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SOIL INVESTIGATION PLAN FOR DIKE STABILITY ANALYSIS OF WASTE PITS 3 AND 5 AND THE CLEARWELL - (USED AS A REFERENCE IN OU1 RI - APPENDIX F)

05/01/91

PARSONS
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REPORT

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Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5 and the Clearwell

United States Department of Energy
Contract No. DE-ACO5-900R21951

May 1991

Prepared By

PARSONS

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6120 South Gilmore
Fairfield, Ohio 45014

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PARSONS

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U.S. DEPARTMENT OF ENERGY

Approved by:	OU-1 Manager	5/17/91 Date
Approved by:	for Project Manager	5/23/91 Date

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SOIL INVESTIGATION PLAN FOR DIKE STABILITY ANALYSIS OF WASTE PITS 3 AND 5, AND THE CLEARWELL

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SECTION 1

INTRODUCTION

1.1 Purpose

This soil investigation plan describes the drilling, sampling, and geotechnical testing program to evaluate the structural stability of dikes bordering Waste Pits 3 and 5, and the Clearwell. A subsurface soil investigation of earthen dike materials, underlying glacial tills and potential seepage/moisture conditions is required to support the Project Plan for Project Order Number 11, dated December 20, 1990. These dikes are located at the Waste Storage Area, Feed Materials Production Center (FMPC) near Fernald, Ohio.

1.2 Approach

Subsurface soil samples will be obtained at specified locations beneath, within, and near the dikes. These samples will be used to identify the physical characteristics of the dike materials present and establish dike subsurface profiles. Geotechnical laboratory testing will be performed on selected samples to determine the relevant engineering properties. Additionally, temporary piezometers will be installed at selected locations to measure the potential water level elevations or seepage conditions in the vicinity of the dikes. With these collected data, engineering calculations will be conducted to evaluate the stability of the dikes.

1.3 Objectives

This soil investigation plan was developed to meet the following objectives:

1) Provide representative and undisturbed subsurface soil samples of earthen materials beneath, within, and near Waste Pits 3 and 5, and the Clearwell dikes for identification, classification, and geotechnical laboratory testing.

2) Provide a means to measure potential water level/seepage conditions associated with Waste Pits 3 and 5, and the Clearwell dikes.

3) Provide engineering material properties for dike stability analysis in order to evaluate the potential for dike failure.

SECTION 2

SITE DESCRIPTION

2.1 FMPC Site

The 1,050-acre FMPC site is located near Fernald, Ohio. United States Geological Survey (USGS) 7.5-Minute Topographic Map, Shandon Quadrangle, Ohio, contains the FMPC site and the surrounding area. Figure 1 shows the FMPC site. The site is located within a two-to-three-mile wide bedrock valley, which is known as the New Haven Trough. This valley is filled with glacial outwash sediments.

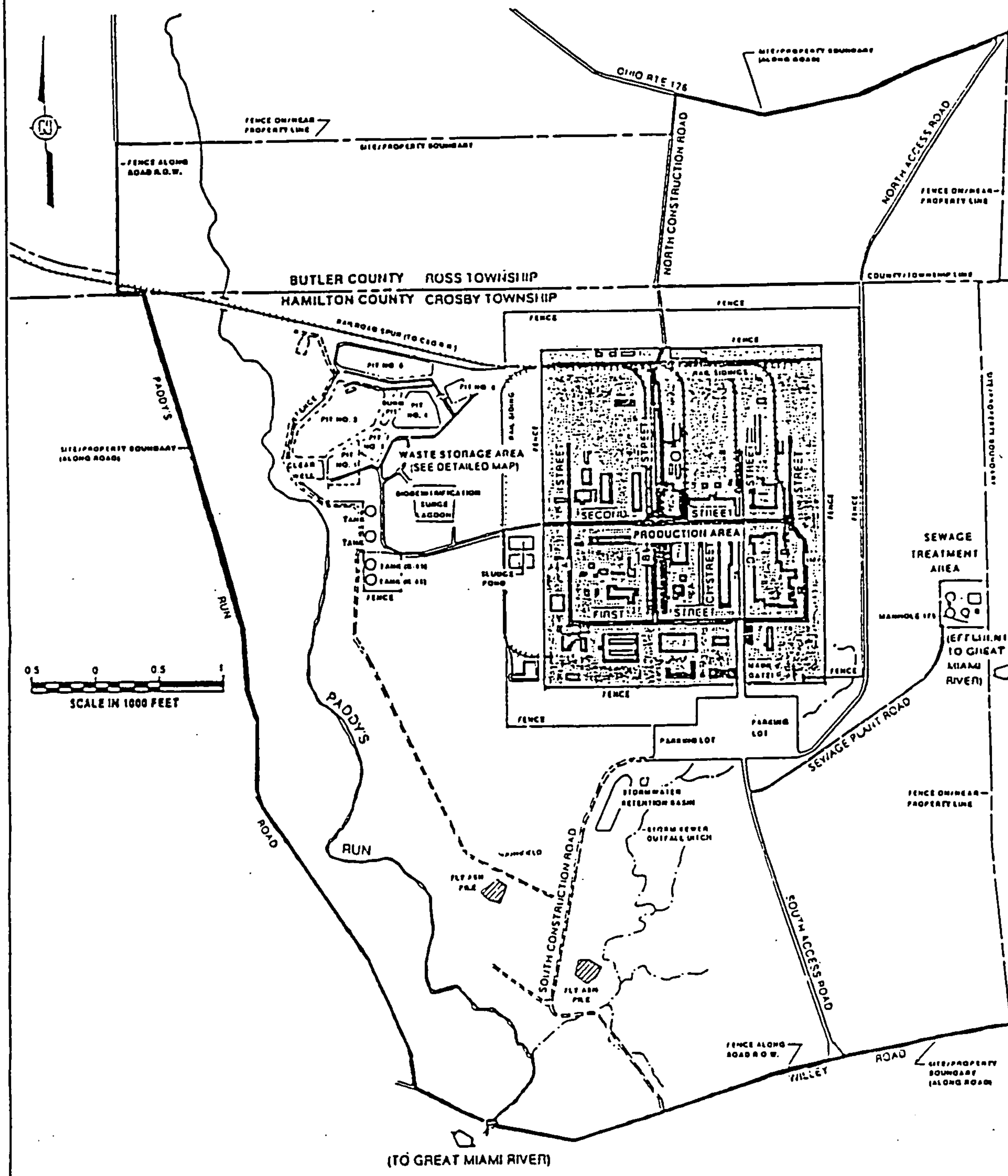
2.2 Waste Storage Area

Six waste storage pits are located in the radiologically controlled Waste Storage Area west of the FMPC production facility (see Figure 2). These pits comprise the principal waste storage units at the FMPC site. Waste Pits 3 and 5 received liquid wastes, while the remaining pits received only dry wastes. Typical wastes deposited in the pits include low-level radioactive wastes associated with uranium metals production; waste materials such as asbestos, barium chloride salt, scrap and trash; and limited quantities of thorium waste. The Clearwell, which captures surface runoff from portions of the Waste Storage Area, is also located in the Waste Storage Area.

Topographic relief of the Waste Storage Area is moderate. The original topography has been highly modified by the cut and fill methods used to construct the waste pits--that is, by excavating an area and using the excavated material to construct berms. A continuous earthen dike, approximately 20 feet high, wraps around the north, west, and south borders of the Waste Storage Area. Waste Pit 5 is completely surrounded by an earthen berm. The 20-foot high dike borders the north and west sides, while an earthen berm, approximately 10 feet high, borders the south and east sides. Waste Pit 3 is covered with earthen fill which forms a gently sloping mound, approximately 10 feet high. A berm, approximately 10 feet high, borders the north and east sides of the Clearwell.

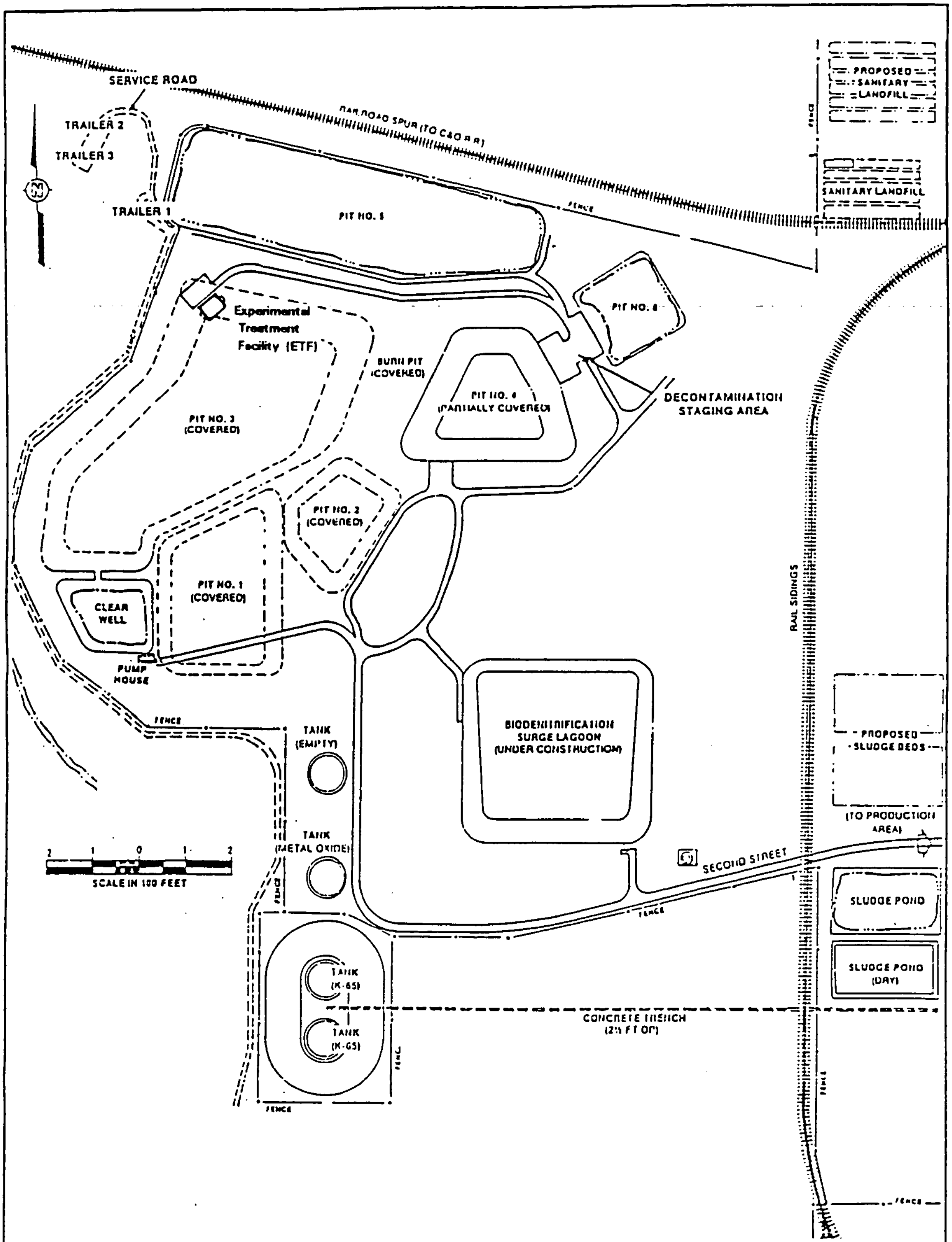
Paddy's Run flows south, just west of the Waste Storage Area, and empties into the Great Miami River. A drainage ditch runs between Waste Pit 5's north dike and the railway embankment, and eventually joins with Paddy's Run northwest of the Waste Storage Area.

Beneath the Waste Storage Area, a layer of approximately 30 feet of glacial till consisting of unsorted clays with occasional sand and silt lenses rests on top of the outwash. Figure 3 shows a fence diagram of this till layer in the vicinity of the Waste Storage Area. Sand and gravel of the Great Miami Aquifer lie beneath the glacial till layer. Data from RI/FS (Remedial Investigation/Feasibility Study) drilling records were reviewed to estimate the maximum elevation of the top of the Great Miami Aquifer beneath the Waste Storage Area. This elevation ranges from approximately 540 to 550 feet above Mean Sea Level (MSL).



(ADAPTED FROM FMPC RI/FS WORK PLAN, REV. 3, 3/88)

Figure 1 - Site Plan - Feed Materials Production Center, Fernald, Ohio



(ADAPTED FROM FMPC RI/FS WORK PLAN, REV. 3, 3/88)

Figure 2 - Plan of the Waste Storage Area

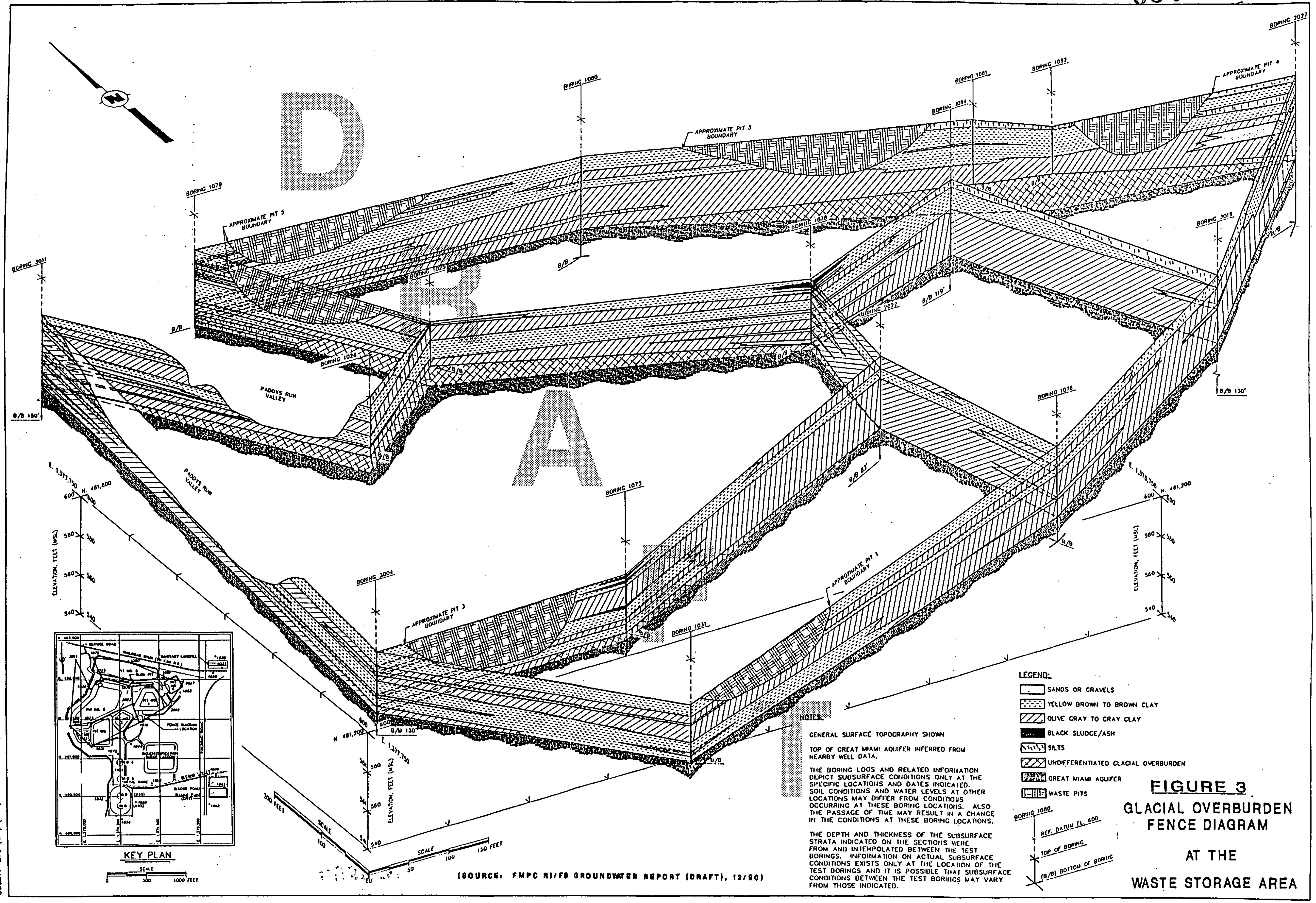


FIGURE 3
GLACIAL OVERBURDEN FENCE DIAGRAM AT THE WASTE STORAGE AREA

303317-E79 (GW) (PGH)

SECTION 3

FIELD PROGRAM

3.1 Introduction

3.1.1 General

The drilling subcontractor will be hired to furnish labor, equipment, and supplies required to make borings, to obtain, to preserve and transport soil samples, to install piezometers, and to grout completed boreholes as required by this soil investigation plan. Technical specifications for subsurface boring, sampling, and piezometer installation are described in Attachment A, "Specifications for Subsurface Boring, Sampling, Installation of Piezometers."

3.1.2 Description of Dikes to be Investigated

3.1.2.1 Waste Pit 3 Dike

Waste Pit 3 was excavated into clay and constructed with clay-lined walls. It operated as a settling basin for liquid wastes between 1959 and 1968. Waste Pit 3 received dry wastes between 1975 and 1977, at which time it was closed and covered with a clean fill cover. The volume of waste within Waste Pit 3 is approximately 227,000 cubic yards (cy).

The Waste Pit 3 dike borders the west boundary of the Waste Storage Area, and is approximately 800 feet long. Its crest is roughly 20 feet high. The slope of the dike varies from approximately 1.5:1 to 1.25:1 (run:rise). Much of the slope is covered with trees and brush. An access road runs parallel to the slope at the base of the dike.

The logs for Borings 1025, 1028, and 3004 (see Attachment B) provide subsurface information obtained during the FMPC Remedial Investigation/Feasibility Study (RI/FS) in the vicinity of the Waste Pit 3 dike. Figures 4 and 5 show the locations of these borings.

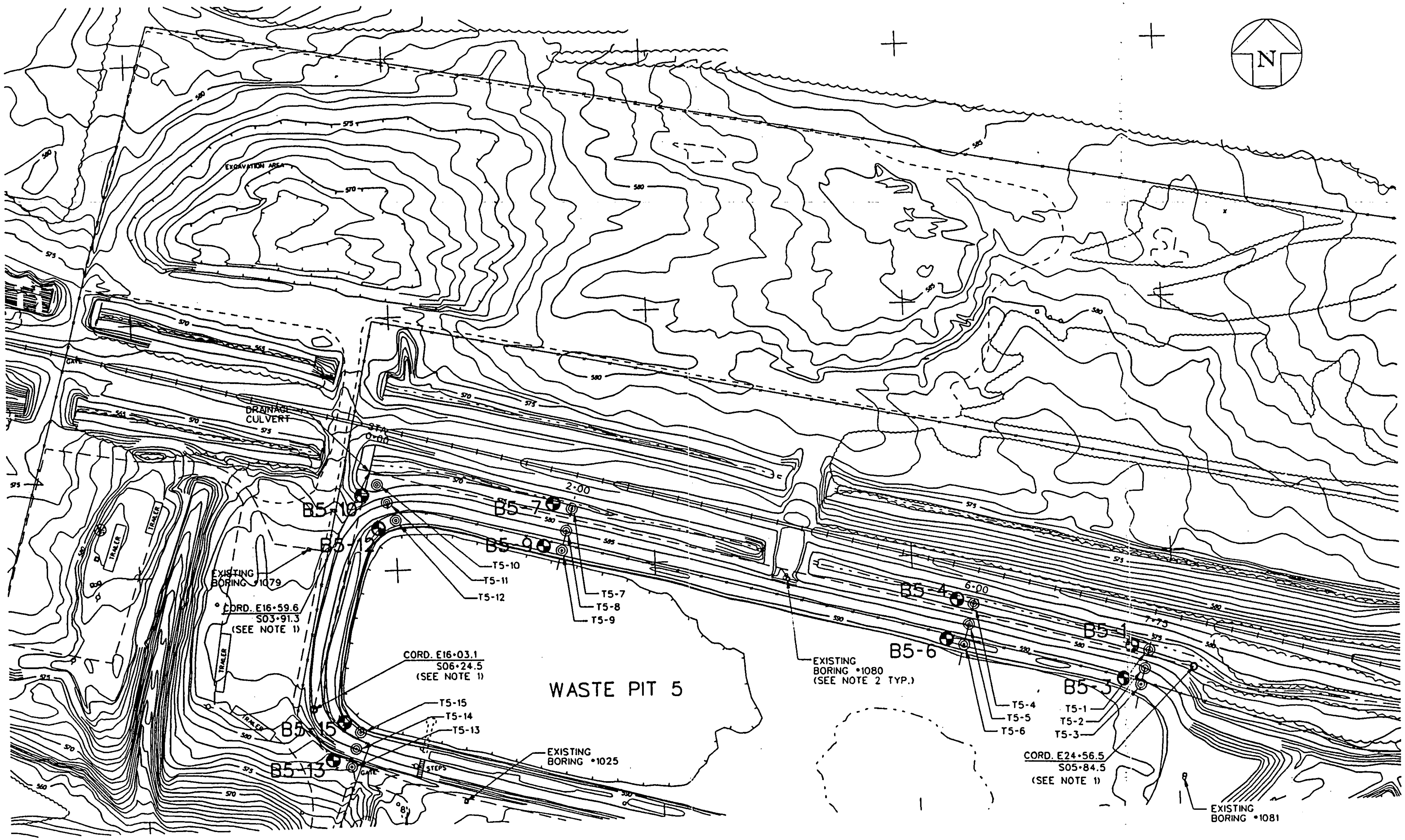


FIGURE 4: WASTE PIT 5 DIKE SAMPLING BOREHOLE LOCATIONS

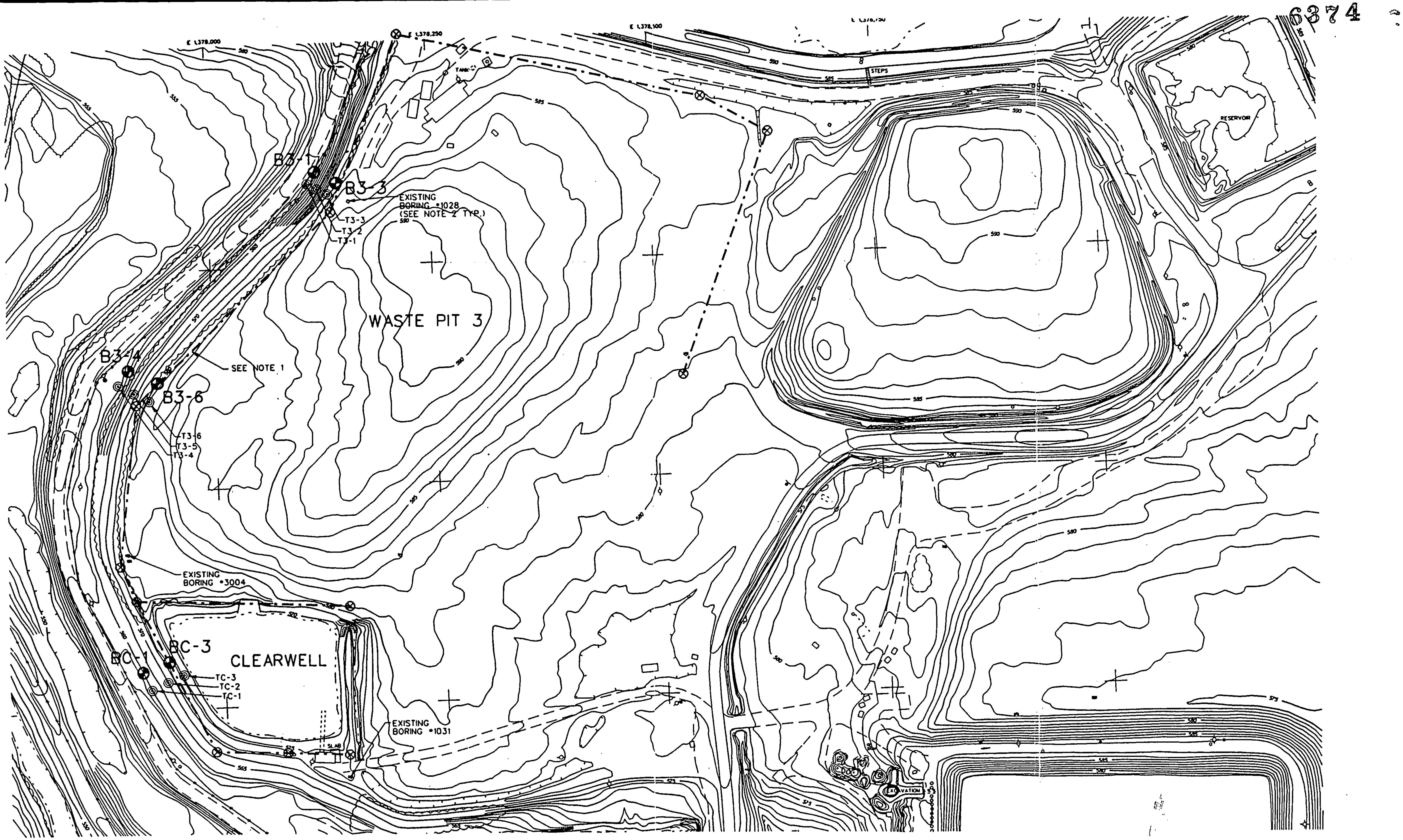
1"=100'-0"

KEY: SURVEY TARGET MONUMENT ◎
PROPOSED BOREHOLE LOCATION

NOTE:

1. COORDINATE POINT WAS OBTAINED FROM WASTE PIT 5 CONSTRUCTION DRAWING (NATIONAL LEAD OF OHIO DWG. NO. 21A-5500-G-00196 (REV 1); 5/22/68).

2. LOCATION OF BORING PERFORMED DURING RI/FS MONITORING WELL INSTALLATION.



KEY: SURVEY TARGET MONUMENT

PROPOSED BOREHOLE LOCATION

NOTES:

1. APPROXIMATE CENTERLINE OF 10'-0" WIDE DIKE CREST. COORDINATES WERE OBTAINED FROM CONSTRUCTION DRAWING NLO 21X-5500-G-00234; 7/16/58

2. LOCATION OF BORING PERFORMED DURING RI/FS MONITORING WELL INSTALLATION.

FIGURE 5: WASTE PIT 3 AND CLEARWELL DIKE SAMPLING BOREHOLE LOCATIONS

1"=100'-0"

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3.1.2.2 Waste Pit 5 Dike

Waste Pit 5 was placed in service in 1968 and operated until 1983 as a surface impoundment receiving high solids-bearing (slurried) waste streams and supernatant from the general sump wastewater treatment system. From 1983 to 1987, Waste Pit 5 received only low solids-bearing wastewater from the general sump treatment operation. The pit is lined with a 60-mil synthetic liner. Presently, the open pit contains areas of standing surface water. The volume of waste within Waste Pit 5 is approximately 102,000 cy.

Waste Pit 5's north dike is approximately 800 feet long and 20 feet high. Waste Pit 5's west dike is approximately 240 feet long and 12 to 15 feet high. Both slopes are approximately 1.5:1. From construction cross section drawings of the Waste Pit 5 north dike, the original ground surface prior to the cut and fill construction is estimated to range from approximately 12 to 18 feet below the present dike crest. A chain link security fence borders the waste pit along the dike's crest. The dike has limited work space at the crest. There exists approximately 10 feet of level surface at the crest (inside the fence) before it gradually slopes (at 2.5:1) into the 30-foot-deep waste pit.

The southwest corner vegetation is representative of moist environments and evidence of burrowing animals was found there. Because of these factors, a specific cross-sectional area of this dike will be investigated.

The logs for Borings 1079, 1080, and 1081 (see Attachment B) provide subsurface information from borings conducted in the vicinity of the north dike of Waste Pit 5. Figure 4 shows the locations of these borings.

3.1.2.3 The Clearwell Dike

The Clearwell receives surface run-off from the Waste Storage Area. Site sources indicate that it was constructed in 1959 and has a 12-inch clay liner. It has a bottom elevation of approximately 548 feet. The Clearwell is used as a settling basin prior to discharge to the Great Miami River via the FMPC National Pollutant Discharge Elimination System (NPDES) discharge point.

The grass covered dike of the Clearwell borders the west boundary of the Waste Storage Area and is approximately 200 feet long and 20 feet high. The slope is approximately 1.5:1. Water of varying depths remains in the Clearwell at all times.

The logs for Borings 1031 and 3004 (see Attachment B) provide subsurface information from borings conducted in the vicinity of the Clearwell. Figure 5 shows the locations of these borings.

3.1.3 Dike Monitoring Program

To supplement this investigation, a monitoring program has been established to construct 24 permanent survey target monuments along dike cross sections and to perform periodic control surveys. The control surveys will determine if any movement is occurring reflecting commencement of dike failure mechanisms. Figures 4 and 5 show the planned locations of the target monuments. The target monuments are scheduled for construction prior to soil sampling operations. Details of the dike monitoring program are described in "Work Plan for Establishment of a Survey Control Net and Survey of Waste Storage Dikes," Parsons, March 1991.

3.2 Soil Boring

The drilling subcontractor will construct suitable borings for soil testing and sampling. The diameter of the boring needs to be of sufficient diameter to accommodate sampling tools. Typically, a four to six-inch diameter borehole will be sufficient. Borings requiring piezometer installation will be no greater than six inches in diameter. The anticipated subsurface conditions will be considered when selecting the drilling method to be used. If the drilling subcontractor is unable to support the walls of the boring, maintain a clean boring and prevent caving of the boring, the WMCO/Parsons Engineer at the site may require the installation of a casing to a depth necessary for successful completion of the field testing and sampling. If casing is required, steel casing of not less than four inches inside diameter, or diameter sufficient to accommodate sampling tools, will be advanced to maintain an open hole for field testing and sampling operations.

Drilling operations will be performed to minimize the introduction of contaminants into the subsurface soil and groundwater. Drilling operations will, if possible, be performed dry. If drilling fluid is necessary, only clear, potable water will be used. The source of water to be used in drilling, grouting, and piezometer installation must be approved by the WMCO/Parsons Engineer.

Soil cuttings from drilling operations will be periodically screened for radioactivity and volatile organics by WMCO safety technicians. The cuttings will be placed in drums provided at the work site by WMCO. Fluids from drilling operations and piezometer installation will be collected in drums and transferred to FMPC Waste Water Treatment System. The use of excavated sumps will not be allowed. The drilling subcontractor may be required to construct a plastic-lined, aboveground holding structure at the work site to contain fluid prior to transfer into drums. WMCO will be responsible for the custody process associated with the soil and fluid drums. This process includes identification of drums, packaging, transport to temporary storage area(s), and sampling/analysis to determine drum disposition. Additionally, WMCO will be responsible for reports associated with sampling/analysis results and drum disposition.

Soil borings will be in accordance with the requirements described in Section 3.01, "Soil Boring," of the Subsurface Drilling Specification (Attachment A).

3.2.1 Sample Borings Location and Depth

Soil borings will be drilled in order to obtain soil samples for visual classification and for laboratory geotechnical testing. The borings will be conducted at designated locations beneath, within, and near the dikes. The borings will be performed adjacent to survey target monuments located at the crest and base of the dikes. Figures 4 and 5 show the approximate locations of the sampling boreholes. Sixteen (16) boreholes are anticipated; eight (8) along the crest, and eight (8) along the base of the dike. The depths of the individual borings will vary depending on borehole location. Borings will not be advanced deeper than 555 feet (MSL) to prevent interception of the Great Miami Aquifer. The estimated depths of the boreholes are listed in Table 1. Sampling below elevation of 555 feet but above the top of the aquifer will be permitted for Waste Pit 3 and Clearwell borings approved by the WMCO/Parsons Engineer. In this case, sampling will proceed cautiously utilizing a continuous sampling interval.

Locations adjacent to survey target monuments were selected for soil sampling to enable correlation of subsurface soil conditions with any movement of target monuments measured by control surveys. The number of borings was selected based on the assumption that the dikes will exhibit relatively uniform subsurface conditions. If non-uniform materials or conditions are encountered, additional borings may be required. The depths of the boreholes were also selected in conjunction with preliminary scoping calculations (Simplified Bishop Method) performed to estimate depth of most probable deep and shallow failure surfaces.

3.2.2 Completed Borehole Grouting

The drilling subcontractor is required to backfill the entire hole with a water-cement-bentonite grout upon completion of each boring (without a piezometer) at the direction of the WMCO/Parsons Engineer. Grouting of completed boreholes will be consistent with the requirements described in Section 3.07 of the Subsurface Drilling Specification, "Grouting of Completed Boreholes" (Attachment A).

3.3 Sampling

Two soil sampling methods will be used to investigate subsurface dike materials. These methods are explained in the following sections.

3.3.1 Split-Barrel Samples

Split-barrel (or split spoon) samples are normally taken while performing a Standard Penetration Test (SPT) in accordance with ASTM D 1586. The SPT consists of driving a standard 2-inch split-barrel sampler 18 inches into undisturbed soil at the bottom of a borehole. A 140 lb weight falling freely from a height of 30 inches is used to drive the sampler. The number of blows required to advance the sampler the last 12 inches is used to obtain an "N" number. The sampler is removed from the borehole and opened. The soil sample is visually identified and classified and a portion is saved for further laboratory index testing discussed in Section 4. The SPT "N" value can provide the field engineer indication of a change in strata or characteristics of the soil being sampled.

Field identification and laboratory index testing of split-barrel samples will provide information needed to develop a model of the dike's subsurface profile for stability analysis. The SPT will be used during the soils investigation as an indicator of changes in strength characteristics of the dike soils being tested. The "N" values obtained as the boring is advanced will assist the WMCO/Parsons engineer in determining appropriate locations to obtain thin-walled tube samples for laboratory testing.

The drilling subcontractor will collect split-barrel samples as required by the WMCO/Parsons Engineer. Standard Penetration Testing (ASTM D 1586) will be performed in conjunction with the split-barrel sampling. A number of the 16 borings described in Section 3.2.1 will require continuous split-barrel sampling to characterize the subsurface profile of the dikes. This number will be determined by the WMCO/Parsons Engineer based on conditions encountered in the field.

Standard Penetration Testing and split-barrel sampling shall be consistent with the requirements of Section 3.02 of the Subsurface Drilling Specification, "Field Testing and Soil Sampling" (Attachment A). The representative samples obtained will be utilized for field identification and classification of the subsurface strata (ASTM D 2488) and index testing described in Section 4.

3.3.2 Thin-Walled Tube Samples

Relatively undisturbed soil samples can be obtained by pushing a thin-walled sample tube (Shelby tube) into the soil at the bottom of a borehole. The tube is carefully removed from the borehole and prepared for transport. The ends of the sample tube are capped to protect the sample. The tubes are packaged in special shipping barrels designed to maintain the samples orientation and prevent shock or vibration during transit. The samples should be protected against freezing or excessive temperatures. Once at the laboratory, the index property and physical property tests described in Section 4 will be performed.

Detailed requirements for obtaining thin-walled tube soil samples are described in ASTM D 1587. Physical properties and index testing of thin-walled tube samples will provide engineering strength and hydraulic parameters for the dike's earthen materials. The parameters will be correlated to the dike's subsurface profile as input to the stability analysis.

The drilling subcontractor will collect thin-walled tube samples as required by the WMCO/Parsons Engineer. Thin-walled tube sampling (ASTM D 1587) will be consistent with the requirements of Section 3.03 of the Subsurface Drilling Specification, "Undisturbed Boring and Soil Sampling" (Attachment A). The undisturbed thin-walled tube sample obtained will be utilized for index and physical properties testing described in Section 4.

3.3.3 Sample Handling and Shipping

The soil samples obtained during the field investigation will require careful handling, packaging, and shipping to an off-site geotechnical testing laboratory. Disturbance and loss of moisture from undisturbed soil samples have serious effects on the properties of the soils, therefore, every precaution should be taken in the handling of the samples. Precautions should be taken to protect samples against exposure, excessive temperature changes, and moisture loss. Additional handling, packaging and shipping requirements may be necessary if potentially hazardous or radioactive samples are encountered during the investigation. Requirements for handling, packaging, and shipping of soil samples obtained during the soils investigation are described in Section 3.04 of the Subsurface Drilling Specification, "Handling and Transportation of Jar and Thin-Walled Tube Samples" (Attachment A).

3.3.4 Sample Identification

Sample borings will be assigned an alphanumeric identification number. A hyphen (-) follows the first two characters of the identification number. The identification number is coded as follows:

First character: "B" (for boring)

Second character: identifies waste pit number (or "C" for the Clearwell)

Third character: identifies adjacent survey target monument.

For example, the designation "B5-3" identifies a sample boring located adjacent to survey target monument number three on the dike of Waste Pit 5.

Samples from the borings will be assigned a unique sample number for identification. Additional borings and samples will be numbered using a similar method.

3.3.5 Sample Containers

Samples will be placed by the drilling subcontractor in appropriate containers for further handling and transport to WMCO for shipment off-site. Split-barrel samples will be placed in moisture proof jars. The jars will then be placed in partitioned boxes or cushioned barrels for transport to the FMPC facility designated to prepare the soil samples for off-site shipment. Upon removal from the borehole, the ends of thin-walled sample tubes will be tightly sealed to prevent disturbance and moisture loss. The tubes will then be packaged upright in specially designed barrels for further transport and shipment. The packing containers will be designed to prevent vibration and shock to the sample tubes during transport. Samples will be shipped off-site in barrels only. Final preparation of barrels for shipment will be performed by WMCO. Requirements pertaining to containers are described in Section 3.04 of the Subsurface Drilling Specification, "Handling of Jar and Thin-walled Tube Samples" (Attachment A).

3.3.6 Sample Labels

Sample jars, tubes, boxes, and barrels will be permanently labeled and/or marked with the appropriate descriptive information. Label and marking requirement are summarized in Section 3.09 of the Subsurface Drilling Specification, "Records and Reports" (Attachment A). Additional labeling and marking may be necessary for potentially hazardous or radioactive samples. WMCO will establish additional labeling and marking requirements necessary.

3.3.7 Sample Chain of Custody

Sample Chain of Custody procedures will be in accordance with the FMPC Remedial Investigation/ Feasibility Study (RI/FS). RI/FS Chain of Custody procedures can be found in Section 7.0 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)", Revision 3, March 1988.

3.3.8 Sample Shipment

Barrels containing soil sample jars and tubes collected during the site investigation will be shipped by WMCO to an off-site geotechnical laboratory for analysis. The transportation of samples will be accomplished in a manner designed to protect the integrity of the sample (ASTM D 4220), and to prevent any detrimental effects from the potentially hazardous nature of the samples. Regulations for packaging, marking, labeling, and shipping of hazardous material, hazardous substances and hazardous wastes are promulgated by the U.S. Department of Transportation (DOT) and described in the code of Federal Regulations (49 CFR 171 through 177), in particular Section 172.402.h, "Packages Containing Samples."

3.4 Piezometer Installation

Piezometers will be installed in selected boreholes designated by the WMCO/Parsons Engineer to measure water level/seepage conditions. Piezometers are planned for boreholes B5-1, B5-3, B5-7, B5-9, B5-13, B5-15, B3-4, B3-6, BC-1, and BC-3.

At the direction of the WMCO/Parsons Engineer, these locations may be changed to other boreholes; or additional piezometers offset from the dikes may be installed based on the moisture conditions of samples, grain size of samples, standing water conditions in the borehole, and SPT blowcount results. Depth and length of screen will be determined by the WMCO/Parsons Engineer, based on similar criteria.

Following installation, piezometers will be maintained and monitored for a period of approximately two months by WMCO. Final piezometer removal and grouting will be conducted by WMCO.

Piezometer installation requirements are described in Section 3.08 of the Subsurface Drilling Specification, "Piezometers" (Attachment A).

3.5 Health and Safety

Health and safety requirements for the soil investigation are described in Attachment C, "Health and Safety Plan for the Dike Stability Investigation of Waste Pits 3 and 5, and the Clearwell." WMCO will provide work permits required by FMPC procedures. Additionally, WMCO will provide the necessary health and safety supervision and personnel to safely conduct the site work.

Subcontractor personnel working on site will complete the necessary FMPC training and medical monitoring requirements prior to commencement of site work. Sections 7.3 and 7.4 of Attachment C describe medical monitoring and training requirements.

3.5.1 <u>Monitoring</u>

Work site monitoring requirements are described in Section 4 of Attachment C. Prior to any task being performed on the waste pit dikes, air monitoring (if required by work permits) will be conducted to ensure that exposure limits are not exceeded. Portable air samplers will be utilized to monitor for airborne radioactive particulates. Radioactive contamination monitoring will be performed when soil media is disturbed in order to ensure any spread of contamination is minimized. While working on waste pit dikes, daily surveys for radioactive surface contamination will be performed in the work area. Direct reading instruments and/or field swipe surveys will be used on drilling and sampling equipment.

Soil samples and drill cuttings removed from boreholes will also be field screened for radioactivity. Radiation surveys will be conducted prior to beginning work and periodically during field activities. Field monitoring will be performed by WMCO Radiological Safety technicians.

Exposure to significant chemical vapor concentrations are not expected during the soil investigation. However, a photoionization detector (Hnu) will be used to monitor the air near the breathing zone of the drilling crew during actual drilling operations. The Hnu will also be used to monitor soil cuttings and samples removed from the borehole. Hnu monitoring will be performed by WMCO technicians.

Thermoluminescent dosimeters (TLDs) will be worn by all field personnel during the soil investigation.

3.5.2 Personal Protective Equipment

The specific personal protective equipment required for each task will be determined at the time the FMPC work permits are issued. Section 5 of Attachment C describes the types of personal protective gear that may be required during field activity of the soil investigation.

3.5.3 Work Site Control

The activities associated with the soil investigation will occur entirely within the FMPC controlled area. Per requirements of 29 CFR Part 1910.120, an exclusion zone (defined by a yellow and magenta barricade rope) will be established and posted around the immediate drilling/soil sampling area. The exclusion zone is a potential hazard area due to physical, chemical, and/or radiological dangers. Access to the exclusion zone will be restricted by Radiological Safety to those trained and certified personnel who are required to enter to perform their job duties. Due to the nature of the drilling activity, the exclusion zone location and configuration will vary for each drilling site.

Radiological Safety will establish a contamination reduction zone, consisting of step-off pads at the exclusion zone exit point. This area will be used for removal of disposable personal protective equipment and limited decontamination of equipment. Work site entry procedures are described in Section 9 of Attachment C. Documented safety meetings will be conducted prior to the start of each day's work.

3.5.4 Decontamination

Decontamination of equipment associated with drilling operations will be conducted at a FMPC decontamination facility. Section 10 of Attachment C discusses decontamination of equipment associated with drilling operations. Equipment exiting an exclusion area will be monitored for contamination by WMCO radiological and environmental safety technicians. Action limits on equipment have been established to initiate decontamination. Only decontamination of sampling equipment and other small-sized equipment (as specified by WMCO) will be allowed at the work site. The spilt-barrel sampler and other sampling equipment, such as trowels, pans, gloves, etc. will be decontaminated between each collected sample by cleaning with water and a brush, rinsing with deionized water, methanol, and deionized water again. Should the sampling equipment become heavily contaminated, it will be decontaminated using the procedure described in Section 6.6 of the RI/FS Work Plan, Volume V, "Quality Assurance Protection Plan," Revision 3, March 1988. Multiple sets of sampling equipment will be provided by the drilling subcontractor to prevent interruption of work while decontaminating equipment. Decontamination of drilling equipment (drill rods, augers, etc.) may be required periodically while advancing the boring in order to minimize the potential spread of contamination. Additionally, drilling equipment that enters a contaminated boring will be cleaned at the FMPC decontamination facility prior to initiating a subsequent boring, in order to prevent cross-contamination. For minor decontamination at the work site, the drilling subcontractor will collect wastewater in drums provided by WMCO for eventual transfer to the FMPC Wastewater Treatment System. WMCO will be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, final disposition, and reporting associated with the wastewater drums.

3.6 Field Quality Assurance/Quality Control

Drilling, sampling, piezometer installation, and laboratory testing have been assigned a Quality Level 3 by WMCO. Site Policy and Procedure Number FMPC-711 provides guidelines for matching of quality program requirements to the quality levels. Specific quality items will be reviewed by WMCO to verify that the quality requirements are adequate and consistent with the assigned quality level. Field quality control should be consistent with guidance provided in Section 11.5 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.

SECTION 4

LABORATORY TEST PROGRAM

4.1 Introduction

Two types of geotechnical laboratory testing will be performed to support the stability analysis of Waste Pits 3 and 5, and the Clearwell dikes. Soil samples obtained from the dikes will undergo index and physical properties testing. Attachment D, "Laboratory Specifications for the Dike Stability Analysis of Waste Pits 3 and 5 and the Clearwell" provides detailed requirements for the laboratory test program.

Index tests consist of specific gravity, unit weight, moisture content, particle size analysis, and the determination of Atterberg Limits (liquid limit, plastic limit and plasticity index). Index properties are used to classify soils, to group soils in major strata, to obtain estimates of physical properties and to correlate the results of physical properties test in one portion of a stratum with other portions of that stratum or other similar deposits where only index test data is available. Specific gravity, in conjunction with unit weight determination, characterize soil volume and weight components. Moisture content is used to compute soil moist weight components. Particle size analysis, in addition to classification, may be applied to seepage and drainage problems. Atterberg limits are used in classification and also as indicators of physical properties.

Physical properties tests required consist of triaxial compression tests, permeability tests and consolidation tests. The triaxial compression test to be performed will be unconsolidated-undrained (UU) and consolidated-undrained (CU). These tests provide shear strength properties that are used in the stability analysis of the earthen dikes. The unconsolidated-undrained test is applicable when the loading is assumed to take place too rapidly for the induced excess porewater pressure to dissipate or for consolidation to occur during the loading period. This test is applicable for conditions such as the end of construction of embankment dams on clays where the permeability is low or where rapid drawdown can occur. It also reflects conditions that occur in soils with minimum overburden or new earthwork construction. The consolidated-undrained strength parameters are applicable for stability analyses where the soils have become fully consolidated and are in equilibrium with existing stress system. Conditions such as rapid application of additional load with no drainage and rapid water drawdown behind earthen dams can be simulated.

Permeability tests are performed to determine a soils coefficient of permeability (hydraulic conductivity). The coefficient of permeability is a property that describe the flow of water through a porous media. The determination of this property is required for analysis of the dikes involving seepage or flow of water.

The type of permeability tests performed can be either constant or falling head procedures. The constant head test is generally suitable for coarse grained soils (less than 10% passing a No. 200 sieve). The falling head test is generally applicable to fine grained soils and is appropriate for the majority of the soil samples anticipated for this project.

One-dimensional consolidation tests are performed to determine compressibility characteristics of soil in order to predict the settlement of structures. The consolidation of fine grained soils that occur over time due to poor water drainage can be estimated utilizing data obtained from such a test.

4.2 Index Testing

The types of index tests to be performed and the appropriate test method are referenced below. These tests can be performed on soil samples obtained from split-barrel samples (ASTM D 1586) or thin-walled tube samples (ASTM D 1587). The test locations and quantities are based on a total of 16 borings described in Section 3.2.1.

Dry Preparation of Soil Samples	ASTM D 421
Standard Soil, Rock and Fluid Terminology	ASTM D 653
Specific Gravity	ASTM D 854
Wet Preparation of Samples	ASTM D 2217
Classification of Soils	ASTM D 2487
Moisture Content	ASTM D 2216
Particle Analysis	ASTM D 422
Atterberg Limits	ASTM D 4318
Unit Weight	U.S. Army Corps of Engineers, Laboratory Soils Testing Manual (EM 1110-2-1906)

The approximate number of tests to be performed are as follows:

1)	Specific Gravity	8
2)	Unit Weight	8
3)	Moisture Content	118
4)	Particle Analysis	48
5)	Atterberg Limits	72

(See Table 1 for a detailed estimate of anticipated sampling and testing requirements)

4.3 Physical Properties Testing

The types of tests to be performed and the test method are referenced below. These tests will be performed on thin-walled tube samples (ASTM D 1587). The test locations and quantities are based on a total of 16 borings described in Section 3.2.1.

Triaxial Compression (CU)	ASTM D 4767
Triaxial Compression (UU)	ASTM D 2850
Constant-Head Permeability	ASTM D 2434
Falling-Head Permeability	U.S. Army Corps of Engineers, Laboratory Soils Testing Manual (EM 1110-2-1906)
One-Dimensional Consolidation	ASTM D 2435

The approximate number of tests to be performed for each test are the following:

1)	Triaxial Compression (CU)	32
2)	Triaxial Compression (UU)	8
3)	Constant-Head Permeability	6
4)	Falling-Head Permeability	16
5)	One-Dimensional Consolidation	12

(See Table 1 for a detailed estimate of anticipated sampling and testing requirements).

TABLE 1

ESTIMATED SAMPLING AND TESTING REQUIREMENTS
FOR WASTE PITS 3 AND 5, AND CLEARWELL DIKE STABILITY ANALYSIS

BORING NO.	BORING DEPTH (FT)	18 IN. SPLIT BARREL SAMPLES (#)	24 IN. SHELBY TUBE SAMPLES (#)	SPECIFIC GRAVITY (#)	UNIT WEIGHT (#)	MOISTURE CONTENT (#)	INDEX TESTS: PARTICLE ANALYSIS (#)	INDEX TESTS: ATTERBERG LIMITS (#)	PHYSICAL PROPERTIES TESTS: TRIAXIAL COMPRESSION UU (#)	PHYSICAL PROPERTIES TESTS: TRIAXIAL COMPRESSION CU (#)	FALLING HEAD PERM (#)	CONSTANT HEAD PERM (#)	1-D CONSOLID. (#)
B5-1	15	8	1			5	2	3	1	1	1		1
B5-3	35	20	2	1	1	12	4	6		3	1	1	1
B5-4	15	8	1			5	2	3	1	1	1		
B5-6	35	20	2	1	1	12	4	6		3	1		
B5-7	15	8	1			5	2	3	1	1	1		1
B5-9	35	20	2	1	1	12	4	6		3	1	1	1
B5-10	15	8	1			5	2	3	1	1	1		
B5-12	35	20	2	1	1	12	4	6		3	1		
B5-13	20	12	1			7	2	3	1	1	1		1
B5-15	35	20	2	1	1	12	4	6		3	1	1	1
B3-1	10	5	1			3	2	3	1	1	1		1
B3-3	25	14	2	1	1	9	4	6		3	1	1	1
B3-4	5	2	1			2	2	3	1	1	1		1
B3-6	25	14	2	1	1	9	4	6		3	1	1	1
BC-1	5	2	1			2	2	3	1	1	1		1
BC-3	15	7	2	1	1	6	4	6		3	1	1	1
TOTALS	340	188	24	8	8	118	48	72	8	32	16	6	12

NOTES: 1. The above listed quantities are estimates only. Actual quantities will be based on actual samples obtained in the field.

2. Boring depth based on bottom of boring elevation = 555 feet (MSL)

po11samp.wk3

Table 1 - Estimated Sampling and Testing Requirements for Waste Pits 3 and 5, and Clearwell Dike Stability Analysis

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ATTACHMENT A

U.S. DEPARTMENT OF ENERGY

FEED MATERIALS PRODUCTION CENTER

DOE Contract No. DE-AC05-900R21951

PROJECT ORDER NUMBER 11

WBS No. 1.2.1.1.2.1.2

DIVISION 2 - SITE WORK

SPECIFICATIONS

Prepared by:

PARSONS
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6120 South Gilmore Road
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U.S. DEPARTMENT OF ENERGY

FEED MATERIALS PRODUCTION CENTER

DOE Contract No. DE-AC05-900R21951

Project Order Number 11

Division 2 - Site Work

Section 02010

PARSONS

Prepared by:	Kevin M. E[illegible] Geotechnical Engineer	5/10/91 Date
Checked by:	Scott [illegible] for Scott Versluis Lead Geotechnical Engineer	5/10/91 Date
Approved by:	Scott [illegible] OU-1 Manager	5/10/91 Date

WESTINGHOUSE MATERIALS CO. OF OHIO

Reviewed by:	Project Engineer	Date
Recommended for Approval by:	OU-1 Manager	Date

U.S. DEPARTMENT OF ENERGY

Approved by:	OU-1 Manager	Date
Approved by:	Project Manager	Date

Date: 05/10/91
Rev. No.: 1

WBS No.: 1.2.1.1.2.1.2
ERA/OU No.: 1

SECTION 02010
SUBSURFACE BORING, SAMPLING, AND
INSTALLATION OF PIEZOMETERS

PART 1 GENERAL

1.01 INTRODUCTION

A. This specification was developed to provide details for subsurface boring, sampling and piezometer installation associated with the dike stability analysis of Waste Pits 3 and 5, and the Clearwell at the Feed Materials Production Center, Fernald, Ohio. For a general description, intent and use of work to be performed see "Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5, and the Clearwell", Parsons, May 1991. Details called for in the Soil Investigation Plan are contained in this specification. This specification is intended to be used with the Soil Investigation Plan and should not be detached and used as a separate document.

B. This Section includes requirements for the following:
1. Soil Boring
2. Field Testing and Soil Sampling
3. Undisturbed Soil Boring and Sampling
4. Handling and Transportation of Jar and Thin-walled Tube Samples
5. Classification of Soil Strata
6. Groundwater Observations
7. Grouting of Completed Holes
8. Piezometers
9. Records and Reports.

1.02 REFERENCES

A. American Society For Testing and Materials (ASTM)
1. ASTM C 33 Standard Specification for Concrete Aggregate

2.	ASTM C 150	Standard Specification for Portland Cement
3.	ASTM D 420-87	Standard Guide for Investigating and Sampling Soil and Rock
4.	ASTM D 653-88	Standard Terminology Relating to Soil, Rock, And Contained Fluids
5.	ASTM D 1452-80	Standard Practice for Soil Investigation and Sampling by Auger Borings
6.	ASTM D 1586-84	Method for Penetration Test and Split-Barrel Sampling of Soils
7.	ASTM D 1587-83	Standard Practice for Thin-Walled Tube Sampling of Soils
8.	ASTM D 2488-84	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
9.	ASTM D 4220-83	Standard Practice for Preserving and Transporting Soil Samples

B. Other

1. Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5, and the Clearwell, Parsons, May 1991.
2. Health and Safety Plan for Dike Stability Investigation of Waste Pits 3 and 5, and the Clearwell, Parsons, May 1991.
3. Feed Materials Production Center (FMPC) Remedial Investigation/Feasibility Study (RI/FS), Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.
4. Westinghouse Materials Company of Ohio (WMCO) Site Policy and Procedure, Number FMPC-711, "Quality Levels."

1.03 SUBMITTALS

A. Daily Time and Material Records. The Drilling Subcontractor shall submit daily time and material records to the WMCO/Parsons Engineer showing the hours worked by each drill rig. These records shall indicate the driller's name for each rig, regular time, and overtime, if any, and all unit price materials used. The records shall be signed daily by the Drilling Subcontractor's representative and by the WMCO/Parsons Engineer. One copy shall be made available to the WMCO/Parsons Engineer no later than the morning following the previous day's work.

B. Boring Logs. At completion of the project, the Drilling Subcontractor shall provide WMCO with three (3) typed office copies of the field boring logs.

C. Shop Drawings. The Drilling Subcontractor shall submit to WMCO at time of bid a complete listing of materials, supplies, and equipment proposed for this work.

1.04 PERMITS AND REGULATIONS

A. WMCO shall determine the applicable FMPC work permits necessary to perform work required by this specification.

B. The WMCO Project Coordinator shall complete required FMPC work permits prior to commencing work.

C. The Drilling Subcontractor shall also be responsible for complying with regulations regarding drilling safety and underground utility detection.

1.05 QUALITY ASSURANCE

A. Work associated with the Waste Pit 3, 5, and Clearwell dike soils investigation shall be consistent with FMPC-711, Quality Level 3 requirements and guidance provided in Section 11.5 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)", Revision 3, March 1988.

1.06 ATTACHMENTS

A. The following items are attached to this section:
1. Figure 1: Elements of Actuating Rod Support System
2. Figure 2: Shipping Barrel for Thin-Walled Tubes.

PART 2 PRODUCTS

2.01 WATER-CEMENT-BENTONITE GROUT

A. The grout mix shall contain 12 parts cement to 1 part bentonite by volume with sufficient water to provide a very thick grout which can be pumped through drill rods.

B. The water/cement ratio will be expressed in gallons of water per 94-pound bags of cement. The water/cement ratio will vary, as directed, generally ranging from 7:1 to 18:1. (These ratios correspond to water/cement ratios of 0.6 to 1.6 lb/lb.)

C. The grout shall be mixed by using an appropriate mixing system which will produce a homogenous growth mix free of lumps.

D. Changes in the water/cement and bentonite/cement ratios beyond the limits shown must be specifically approved by the WMCO/Parsons Engineer.

2.02 SAND

A. Concrete sand shall conform to the fine aggregate gradation of ASTM C 33.

2.03 PIEZOMETER CASING AND SCREEN

A. Piezometer casing shall consist of 2-inch nominal diameter pipe Schedule 40 PVC.

B. Piezometer screen shall consist of standard 2-inch diameter Schedule 40 or 80 PVC wellpoint with #20 slot (0.020 in. slots), 5 feet in length. The wellpoint pipe shall have a closed bottom.

PART 3 EXECUTION

3.01 SOIL BORING

A. Soil borings are made to determine the nature, arrangement, thickness, and texture of various soil strata as they exist in the ground. Every effort should be made to locate and record the datum elevation at which any change in stratification occurs. Representative samples at the soils natural water content shall be obtained from each stratum. Each sample, as it is removed from the ground, should be packed so that it will reach the laboratory in as near as possible the condition in which it was removed from the ground without loss of water or damage by freezing, heating, breakage of containers, or other disturbances in transit.

B. The boring shall be advanced to ensure satisfactory field testing and sampling. Drilling procedures shall provide a suitable clean and stable hole before insertion of samplers and assure that testing and sampling is preformed on essentially undisturbed soil.

C. The anticipated subsurface conditions should be considered when selecting the drilling method to be used.

D. Drilling operations shall be performed as to minimize the introduction of contaminants into the subsurface soil and groundwater.

E. Drilling operations should be performed dry. If drilling fluid is necessary, only clear potable water should be used. The source of water to be using in drilling must be approved by the WMCO/Parsons Engineer.

F. Decontamination of equipment (drill rig, drill rods, augers, etc.) associated with drilling operations shall be conducted at a FMPC decontamination facility specified by WMCO. Only decontamination of sampling equipment (samplers, trowels, pans, gloves, etc.) and other small-sized equipment (as specified by WMCO) shall be allowed at the work site. Decontamination shall follow procedures described in Section 6.6 of the RI/FS Work Plan, Revision 3, March 1988.

G. Drilling and sampling equipment utilized in contaminated soils shall be decontaminated between borings to prevent cross-contamination.

H. Decontamination of drill equipment shall be performed periodically as a boring is advanced to minimize the potential spread of contamination.

I. Multiple sets of sampling equipment shall be provided by the Drilling Subcontractor to prevent interruption of work while decontaminating equipment.

J. During drilling operations, soil cuttings shall be field screened periodically for radioactivity and volatile organics by WMCO radioligical and environmental safety technicians.

K. Soil cuttings shall be placed in drums provided at the work site by WMCO. WMCO shall be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, final disposition, and reporting of drummed soil cuttings in accordance with WMCO procedures.

L. Drill fluid removed from a borehole during drilling operations shall be collected in drums provided by WMCO or in a plastic-lined aboveground holding structure established by the drilling subcontractor for temporary collection prior to transfer to drums. Drums of drill fluid shall be transferred by WMCO to the FMPC Waste Water Treatment System. WMCO shall be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, final disposition, and reporting of drummed drill fluid in accordance with WMCO procedures.

M. Boring advancement using solid-stem, single flight (one section) augers shall follow procedures described in ASTM D 1452, "Standard Practice for Soil Investigation and Sampling by Auger Borings" (ASTM D 1452 does not apply to continuous flight augers).

N. The continuous flight solid stem auger method shall not be used to advance the boring below a water table.

O. Boring advancement using rotary drilling methods shall utilize clean, potable water for drill fluid.

P. The diameter of the boring shall be of sufficient diameter to accommodate all required sampling tools. If the drilling subcontractor is unable to support the walls of the boring, maintain a clean boring and prevent caving of the boring, the WMCO/Parsons Engineer at the site may require the installation of casing to a depth necessary for successful completion of the field testing and sampling. If casing is required, steel casing of not less than four inches inside diameter, or diameter sufficient to accommodate all required sampling tools, shall be advanced as required to maintain an open hole for field testing and sampling operations. The casing shall have flush joints. Oversize couplings will only be allowed if specifically approved by the WMCO/Parsons Engineer. In no case shall the casing be advanced to a depth greater than the depth at which field testing or sampling is to be undertaken. In advancing the borehole using the casing-advancement method, the casing shall be advanced without washing, to depths as directed by the WMCO/Parsons Engineer, after which the material shall be cleaned out of the bottom of the casing by using a cutting or chopping bit. Drill fluid may be forced down through the drill rods and out through ports in the drilling bit to carry the cuttings up and out of the boring. It is imperative that fluid ports in the drilling bit be so arranged that there is no jetting action of the drill fluid ahead of the bit. In no case shall the cleaning operation proceed beyond the lower limit of the casing unless specified by the WMCO/Parsons

Engineer. The minimum amount of drill fluid necessary to carry away the cutting shall be used.

Q. The drill fluid level within the boring or hollow stem auger shall be maintained at or above the groundwater level during drilling, drill rod removal, and sampling. As the boring is advanced, special care shall be taken to note the depths below the ground surface at which there is a loss or gain of the drill fluid in the boring.

R. All drilling equipment, including drill rigs, are to be in good working order at all times throughout the duration of the soil investigation. If, in the opinion of the WMCO/Parsons Engineer, the equipment supplied is inadequate for conducting the required tests or for obtaining the desired samples, it shall be placed immediately with suitable equipment at the Drilling Subcontractor's expense.

3.02 FIELD TESTING AND SOIL SAMPLING

A. Standard Penetration Tests shall be conducted in accordance with ASTM D 1586 "Standard Method for Penetration Test and Split-Barrel Sampling of Soils." Standard Penetration Tests shall be conducted at every change in strata and, within a continuous strata, at intervals not to exceed 5 feet on center (2.5 feet on center for the first 15 feet). Continuous Standard Penetration Tests shall be conducted if so directed by the WMCO/Parsons Engineer. Thin-walled tube samples may be specified in lieu of the split-barrel sample of the Standard Penetration Test by the WMCO/Parsons Engineer.

B. The standard sampler may be driven utilizing a Rope-cathead, trip, semi-automatic or automatic hammer drop system. The hammer shall weigh 140 +/- 2 lb, be a solid metallic mass, and make steel to steel contact when dropped. A hammer fall guide which permits free fall shall be used.

C. Rope-cathead method hammers shall have an unimpeded overlift capacity of at least 4 inches. Catheads used shall be essentially free of rust, oil and grease. Cathead shall have diameters in the range of 6 to 10 inches. The cathead should be rotated at a minimum rate of 100 RPM, otherwise, the approximate speed of rotation shall be reported on the boring log. No more than 2-1/4 rope turns on the cathead may be used during the performance of the penetration test. (See ASTM D 1586 for definition of the number of rope turns.) The rope used to lift the hammer should be made of tightly wound hemp or other approved rope made of natural fiber. The rope should be maintained in a relatively dry, clean, and unfrayed condition.

D. The standard split-barrel(spoon) sampler shall be driven with a guided hammer or ram into the undisturbed soil below the bottom of the boring, after the boring has been cleaned to remove all loose and foreign material. The sampling spoon shall be a 2-inch outside diameter split-barrel sampler with an inside diameter of 1-3/8-inch. The inside of the split-barrel shall be flush with the inside of the drive shoe.

E. The bottom of the sampler shall be sharpened to form a cutting edge at its inside circumference. The beveled edge of the drive shoe shall be maintained in good condition and, if excessively worn, shall be reshaped to the satisfaction of the WMCO/Parsons Engineer. The drive shoe of the sampler shall be replaced if damaged in such a manner as to cause projections within the interior surface of the shoe. Each drill rig shall be equipped with a minimum of two drive shoes in good condition.

F. At the discretion of the WMCO/Parsons Engineer, a perforated section of drill rod shall be used immediately above the sampler to ensure that the drill fluid does not collect in the drill rods while the sampler is being withdrawn. A minimum of six holes of 0.5-inch diameter should be present over a distance of two feet immediately above the sampler.

G. Drill rods shall be marked in three successive 6-inches increments so that the advance of the sampler for each can be easily observed by the operator. The sampler shall be driven with blows from the 140-pound hammer with 30-inch free fall. The number of blows applied in each 6-inch penetration shall be counted during driving. Driving the sampler shall be terminated if one of the following occurs:

1. A total of 50 blows have been applied during any one of the three six-inch increments
2. A total of 100 blows have been applied
3. There is no observed advance of the sampler during 10 consecutive blows.

H. The sampler shall be advanced 18 inches unless one of the described limiting blow counts is reached. The number of blows required to cause each 6 inches (or fraction) of penetration obtained shall be recorded.

I. Upon reaching a water table, particular care must be exercised to maintain the hole full of drill fluid at a higher level than the groundwater level preceding and during the Standard Penetration Test. During the removal of the sampler from the borehole after sampling, a positive inflow of fluid at the top of the casing shall be maintained.

J. Trap doors of the flap type protruding at any point into the inside diameter of the sampler may not be used. A spring or basket type retainer shall be used only when necessary to prevent loss of the sample.

K. Care must be exercised while the sampler is being removed from the hole and while the sample is being removed from the sampler to prevent vibration of the rods or sampler by hitting the rods with a wrench or ramming the spoon while opening it.

L. Immediately upon removal from the hole, the soil shall be carefully disassembled. Field screening for radioactivity and volatile organics by WMCO radiological and environmental safety technicians shall be performed during disassembly. The soil shall then be classified. The percent recovered or length of the sample shall be recorded in the boring logs. The most representative and least disturbed portion of the sample shall be placed into moisture-proof container (mason type jars) without ramming or distorting any apparent stratification. The WMCO/Parsons Engineer may request that the samples be placed in clear plastic bags before inserting the samples into the jars. Where a strata change occurred within the spoon sampler, a sample of each material shall be taken and placed in separate jars. The depth of the change shall be recorded in the sampling logs and on the jar labels. The lid of each jar shall be securely fastened. The jar shall be properly labeled as to project number and site, boring number, number of the sample, date of sample, depths at both top and bottom of the sample, number of blows for each 6 inches of penetration, and other pertinent information. Additional marking, labeling and accompanying instructions may be required by WMCO as a result of the field radiological and environmental screening.

M. Remaining sample material from spoon will be placed in a jar and labeled as described with additional markings to indicate that the jar is to be stored for archival purposes and should not be shipped to the laboratory for testing. (Archival sample jars will be transferred to WMCO for storage and final disposition.) If the length of the sample recovered is less than 3 inches, the entire sample shall be placed in the sample jar.

N. If a soil sample is loose or is found unsatisfactory by the WMCO/Parsons Engineer as to size or condition, a second attempt shall be made to obtain a satisfactory soil sample before advancing the boring to a lower elevation. Wash samples will not be accepted. If in the opinion of the WMCO/Parsons Engineer, a recovered sample is wash material resulting from the cleaning operation, the drilling subcontractor shall remove all such material from the boring using a standard clean-out auger, or a clean-out auger with sludge barrel if necessary, to the lower limit of the previous sample, and a second attempt shall be made to obtain a satisfactory sample.

O. When very soft cohesive or water-bearing granular soils are encountered, the hole must be maintained full of drill fluid or at a level higher than the groundwater level at all times to reduce the possibility of soil flowing upward into the borehole.

P. Where extremely compact material prevents further advance of the boring by driving casing or by the wash method, the use of appropriate bits (fishtail, etc.) will be permitted with the approval of the WMCO/Parsons Engineer.

Q. Packaging, handling, and shipping of samples shall proceed as described in Section 3.04.

R. The split-barrel sampler and other sampling equipment (trowels, pans, gloves, etc.) shall be decontaminated between each collected sample by cleaning with clean, potable water and a brush, rinsing with deionized water, methanol, and deionized water again. Should sampling equipment become heavily contaminated, it will be decontaminated using the procedure described in Section 6.6 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.

S. Water from decontamination shall be collected in drums for transfer to the FMPC Wastewater Treatment System. WMCO shall be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, final disposition, and reporting of drummed water in accordance with WMCO procedures.

3.03 UNDISTURBED SOIL BORING AND SAMPLING

A. Undisturbed soil samples shall be obtained by means of a Shelby tube, Osterberg piston, pitcher barrel, or stationary fixed piston sampler in accordance with ASTM D 1587, "Standard Practice for Thin-Walled Sampling of Soils."

B. At locations in the soil strata selected by the WMCO/Parsons Engineer, undisturbed soil samples shall be recovered by means of a thin-walled tube sampler. Dimensions of the thin-walled samplers provided by the Drilling Subcontractor shall be:

1. Outside diameter: 3 inches
2. Tube length: 36 inches
3. Wall thickness: 0.065 in (16 Bwg)
4. Inside Clearance Ratio: 1%

Inside Clearance Ratio = $[(D_i - D_c) / D_c] \times 100\%$

where: D_i = Inside diameter of the tube

D_c = Inside diameter of cutting edge

C. Dimensional tolerances for the thin-walled sample tubes shall be within the limits of those listed in ASTM D 1587.

D. Sampler tubes shall be new, clean, and free of all surface irregularities including dents, scars and projecting weld seams.

E. Sampler tubes shall be made of 16-gage brass, hard aluminum, or steel seamless tubes. If steel tubes are used, they shall be properly cleaned and polished on the inside and fully coated with lacquer, epoxy, Teflon, or equivalent.

F. Borings shall be made as specified under Sections 3.01 and 3.02. For thin-walled tube samples, open borehole diameter and the inside diameter of borehole casing (or hollow-stem auger) shall not exceed 10.5 inches.

G. When ready to take samples, all loose materials shall be removed to the bottom of the casing or open boring. Cleaning out shall be done in such a manner that the soil immediately below the bottom of the open hole shall be as nearly undisturbed as possible. The sampling device connected to the drilling rod shall then be lowered slowly to the bottom of the hole and the sampler pressed into the soil for a distance of 24 inches (or for a distance specified by WMCO/Parsons Engineer, not to exceed 30 inches).

H. Sampling equipment (trowels, pans, gloves, etc.) shall be decontaminated between each collected sample by cleaning with potable water and a brush, rinsing with deionized water, methanol, and deionized water again. Should the sampling equipment become heavily contaminated, it will be decontaminated using the procedure described in Section 6.6 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.

I. Water from decontamination shall be collected in drums for transfer to the FMPC Wastewater Treatment System. WMCO shall be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, final disposition, and reporting of drummed water in accordance with WMCO procedures.

J. Undisturbed Thin-Walled Tube Sample Using A Stationary Fixed Piston Sampler
   1. The boring shall be advanced as described in Sections 3.01 and 3.02.
   2. Thin-walled tubes shall be provided as specified above.
   3. The Drilling Subcontractor shall provide the equipment shown in attached Figure 1 for securing the actuating rods during fixed piston sampling.

4. The sampler shall be checked for condition according to the following list:
   a. Piston head water ports clean
   b. Piston vacuum port clean
   c. Piston head locking cone seat clean and free of rust
   d. Piston head threads in good condition and well greased
   e. Piston leathers present and in good condition
   f. Piston threads for actuating rod in good condition, oiled, and can be turned easily
   g. Threads on actuating rod to fit piston in good condition, lower 3 inches (approximate) of rod is beveled flat on one side to allow for vacuum break. The beveled edge should occur on the threads of the piston rods only.
   h. Piston actuating rod straight and free of dents, burrs, and rust.
5. The sampler and sampling tube shall be assembled and prepared for sampling according to the following list:
   a. Piston actuating rod tightly threaded into piston, blocking the vacuum port, before lowering the sample down the borehole
   b. Piston placed at bottom of sampling tube with tube resting on wood or other soft material
   c. Piston head placed and bolted to top of tube
   d. Locking cone in good condition and in place, large end up
   e. Spring in place above locking cone
   f. Adapter in place on piston head
   g. Actuating rods used inside drill rods.
6. After the hole has been thoroughly cleaned, as specified in Section 3.01, the sampler and tube shall be lowered carefully into the hole. String should be used in rod joints to aid in unscrewing joints without vibration. The actuating rod should be locked to the drill rod during the last a 1 to 2 feet down the borehole. The sampler shall be gently placed on the bottom of the borehole. Before pushing the tube, the actuating rod shall be locked

to the support frame shown in attached Figure 1, then the actuating rod should be released from the drill rods.

7. With the sampling tube resting on the bottom of the hole, the tube shall be pushed into the soil using the hydraulically operated drill head of the rig. A positive connection between the drill rods and the drill head, such as that shown in Figure 1 shall be used. The tube shall be forced into the soil by a continuous and rapid motion without impact or twisting, under steady pressure at the rate of 4 to 8 in per second, unless otherwise directed. The tube shall not be pushed further than the length provided for the soil sample. A pressure gage shall be attached to the hydraulic system used to push the tube so that the force to press the tube can be computed.
8. The sample shall then remain at rest for a minimum of ten (10) minutes to ensure that sufficient friction between the sample and the tube develop. Before the tube is pulled, it shall be turned at least two revolutions to shear the sample off at the bottom. Other techniques may be used to ensure recovery of the sample, if approved by the WMCO/Parsons Engineer.
9. The actuating rod shall then be locked to the drill rod. The tube shall be withdrawn from the bottom of the hole in a smooth constant motion using hydraulic pressure to pull the tube at a rate of 1-inch per second or less. After the sample has been pulled free of the bottom of the hole a distance of about 2 feet, the actuating rod shall be unlocked from the drill rod, and removal of the sampler shall continue at a slow uniform withdrawal rate not to exceed 1-foot per second.
10. Breaking the rod joints during withdrawal of the sampler shall be done carefully in as large sections as can be practically handled so as not to disturb the samples. Extreme care must be exercised while the sampler is being removed from the hole and while the thin-walled tube is being removed from the

sampler to prevent vibration of the rods or sampler by accidentally hitting the rods with a wrench or similar device. Field screening for radioactivity and volatile organics by WMCO radiological and environmental safety technicians shall be performed on the thin-walled sample tube upon removal from the borehole. The bottom of the thin-walled tube shall be capped immediately as it is removed from the casing.

11. Water shall be added to the boring in order to ensure that the fluid level is near the top of the casing during withdrawal of the rods and sampler.
12. Where continuous sampling is required, the tube sampling procedure shall be repeated within the limits specified so as to obtain a continuous vertical section of the subsoils. Following each sampling operation, the casing shall be advanced if required and the hole cleaned out, care being taken not to drive the bottom of the casing below the level of the bottom of the last sample taken as specified in Section 3.01. Continuous sampling shall proceed in this manner until the specified depth is reached.
13. Sealing, marking, handling, and shipping shall proceed as described in Section 3.04.

K. Undisturbed Open Drive Thin-Walled Tube Samples

1. The boring shall be advanced as described in Sections 3.01 and 3.02.
2. Thin-walled tubes shall be provided as specified above.
3. The check valve in the sampler head shall be inspected before each use to ensure that it is in good working condition.
4. After the hole has been cleaned, as specified in Section 3.01, the assembled sampler and tube shall be lowered carefully into the hole. Drill rods shall be in good condition such that joints can be tightened easily and flush with each other. Care shall be taken not to allow the sampling tube to

press into the soils beneath the sampler until the last moment before pressing the tube.

5. With the sampling tube resting on the bottom of the hole, the tube shall be forced into the soil by a continuous rapid motion without impact of twisting, under a steady rate of 4 to 8 inches per second unless otherwise directed. The tube shall not be pushed further than the length provided for the soil sample. Precautions must be taken not to use pressure high enough to damage the thin-walled tube.
6. The sample shall remain at rest for a minimum of ten (10) minutes to ensure that sufficient friction between the sample and the tube will develop. Before the tube is pulled, it shall be turned at least two revolutions to shear the sample off at the bottom. Other techniques may be used to ensure recovery of the sample if approved by the WMCO/Parsons Engineer.
7. The tube shall be withdrawn from the bottom of the hole in a smooth, constant motion using hydraulic pressure to pull the tube at a rate of 1-inch per second or less. After the sample has been pulled free from the bottom of the hole a distance of about 3 feet, removal shall continue at a slow, uniform rate not to exceed one foot per second.
8. Breaking of the rod joints during withdrawal shall be done carefully in as large sections as can be practically handled so as not to disturb the samples. Extreme care shall be exercised while the sampler is being removed for the hole and while the thin-walled tube is being removed from the sampler to prevent vibration to the rods or sampler by accidentally hitting the rods with a wrench or similar device. Field screening for radioactivity and volatile organics by WMCO radiological and environmental safety technicians shall be performed on the thin-walled sample tube upon removal from the borehole. The bottom of the thin-walled tube shall be capped immediately as it is removed form the casing.

9. Water shall be added to the boring in order to ensure that the fluid level is near the top of the casing during withdrawal of the rods and sampler.
10. Where continuous sampling is required, the tube sampling procedure shall be repeated within the limits specified so as to obtain a continuous vertical section of the subsoils. Following each sampling operation, the casing shall be advanced if required and the hole cleaned out, care being taken not to drive the bottom of the casing below the level of the bottom of the last sample taken as specified in Section 3.01. Continuous sampling shall proceed in this manner until the specified depth is reached.
11. Sealing, marking, handling, and shipping shall proceed as described in Section 3.04.

L. Undisturbed Thin-Walled Samples Using an Osterberg Piston Sampler
1. The boring shall be advanced as described in Sections 3.01 and 3.02.
2. Thin-walled tubes shall be provided as specified above.
3. The sampler shall be checked for condition according to the following list:
   a. Water ports in sampler head
   b. Cap screw tightly secured in the vacuum port
   c. Outer cylinder is tightly secured to the sampler head
4. The sampler and sample tubing shall be assembled and prepared for sampling being sure that the thin-walled tube is tightly secured to the moveable piston and the movable piston top of the thin-walled tubes are placed at the top of the inside of the sampler.
5. After the hole has been thoroughly cleaned as specified in Section 3.01, the assembled sampler shall be lowered carefully into the hole. Drill rods shall be in good condition such that joints can be tightened easily and flush with each other. The sampler shall be placed in as close contact as

possible with the bottom of the hole to ensure that little or no drill fluid will enter the sampling tube. However, care shall be taken not to compress the soil beneath the sampler until the last moment before inserting the tube.

6. The drill rods shall be secured to the top of the casing or to the drill rig in a manner such that the resistance is sufficient to ensure that the rods do not move upward during insertion of the sampling tube. Upon approval from the WMCO/Parsons Engineer, other means may be used as necessary to avoid movement of the rods.
7. Before insertion of the tube, the power on the pump shall be increased so that full pressure will be immediately available to the sampler's hydraulic system. Only water shall be used in the drill rods to actuate the moveable piston and the thin-walled tube. The sample tube shall then be hydraulically forced into the ground. The hydraulic pressure used for sampling shall be observed and recorded.
8. The tube shall be withdrawn from the bottom of the hole in a smooth constant motion using hydraulic pressure to pull the tube at a rate of 1-inch per second or less. After the sample has been pulled free from the bottom of the hole a distance of about 3 feet, removal shall continue at a slow uniform rate not to exceed one foot per second.
9. Breaking of the rod joints during withdrawal shall be done carefully in as large sections as can be practically handled so as not to disturb the samples. Extreme care shall be exercised while the sampler is being removed for the hole and while the thin-walled tube is being removed from the sampler to prevent vibration to the rods or sampler by accidentally hitting the rods with a wrench or similar device. Field screening for radioactivity and volatile organics by WMCO radiological and environmental safety technicians shall be performed on the thin-walled sample tube upon removal from the borehole. The bottom of the thin-walled tube shall

be capped immediately as it is removed form the casing.

10. Water shall be added to the boring in order to ensure that the fluid level is near the top of the casing during withdrawal of the rods and sampler.
11. Where continuous sampling is required, the tube sampling procedure shall be repeated within the limits specified so as to obtain a continuous vertical section of the subsoils. Following each sampling operation, the casing shall be advances if required and the hole cleaned out, care being taken not to drive the bottom of the casing below the level of the bottom of the last sample taken as specified in Section 3.01. Continuous sampling shall proceed in this manner until the specified depth is reached.
12. Sealing, marking, handling, and shipping shall proceed as described in section 3.04.

3.04 HANDLING AND TRANSPORTATION OF JAR AND THIN-WALLED TUBE SAMPLES

A. Preservation, handling, transportation, and shipment of all soil samples shall be in accordance with the standard practices described in ASTM D 4220, "Standard Practices for Preserving and Transporting Soil Samples."

B. Chain of Custody procedures for soil samples shall be as per the FMPC Remedial Investigation/Feasibility Study (RI/FS) Work Plan. RI/FS Chain of Custody Procedures can be found in Section 7.0 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.

C. Soil samples collected during site investigation operations will be transported to off-site laboratories for analysis. The transportation of samples must be accomplished in a manner designed to protect the integrity of the sample per ASTM D 4220 and prevent any detrimental effects from the potentially hazardous nature of the samples. Regulations for packaging, marking, labeling, and shipping of hazardous material, hazardous substances, hazardous wastes, and radioactive material and waste are promulgated by the U.S. Department of Transportation (DOT) and described in the code of Federal Regulations (49 CFR 171 through 177), in particular 172.402.h, "Packages Containing Samples."

D. The Drilling Subcontractor shall preserve, package, and transport all soil samples obtained in the field in accordance with the standard practices established in ASTM D 4220. Custody of boxes or barrels containing the soil samples shall be transferred to WMCO for shipment document preparation, packaging, and final preparation for shipment to the geotechnical testing laboratory. Only barrels shall be used by WMCO to ship soil samples off-site. The Drilling Subcontractor shall provide WMCO with the appropriate instructions, procedures, and supervision to ensure that soil samples are handled, packaged, and shipped in a manner consistent with ASTM D 4220.

1. Handling preparation, packaging, documentation, and labeling of barrels for shipment to an off-site geotechnical testing laboratory shall be in accordance with WMCO procedures and DOT regulations.
2. Soil samples classified as hazardous or radioactive shall be handled, prepared, packaged, labeled and shipped in accordance with WMCO procedures and applicable DOT regulations. Important features of applicable DOT regulations, with their application to samples contaminated with uranium and associated daughter products, are summarized in 49 CFR 173.

E. Split-Barrel Samples

1. Samples obtained from split-barrel samplers shall be preserved, handled, and transported in a manner consistent with "Group B" samples described in ASTM D 4220.
2. Any sample container (jar, box, or barrel) containing hazardous materials (radioactive, toxic, volatile, other contaminants) as determined from field screening by WMCO radiological or

environmental safety technicians shall be marked with the appropriate instructions, descriptions, warnings, and labels. Special instructions, as appropriate, shall accompany the containers.

3. Split barrel samples obtained during site investigations shall be preserved in sealed, moisture-proof containers (glass or plastic waterproof jars). Jars shall be wide-mouthed, with rubber-ringed lids lined with a coated paper seal and of a size to accommodate the sample (commonly 1 pt or quart sized). If jar lids are not rubber ringed or lined with new waxed paper seals, the lids shall be sealed with wax.
4. The jars shall be packaged in durable cardboard or wooden boxes that contain individual partitions for each jar. The outside of the box shall be permanently marked with project number and site, boring number, sample numbers, sample depths. Packaging samples from more than one boring in an individual box is acceptable, if the box is so marked. Cardboard boxes may be placed within wooden boxes for transport. No more than two cardboard boxes per wooden box are allowed.
5. Wooden boxes shall be marked to identify project number and site, boring numbers, sample numbers and sample depths.
6. Samples may be transported by any available transportation. If samples are transported by the Drilling Subcontractor in an automotive vehicle, the wooden boxes are not required.
7. The samples shall be protected from freezing temperatures and excessive heat at all times.
8. WMCO shall repackage sample jars into barrels for shipment off-site. Sample jars shall be surrounded with packing material in a manner so as to protect against vibration and shock during shipment.
9. The WMCO/Parsons Engineer may elect to have WMCO perform handling and transportation of all samples.

caps shall be sealed with waterproof plastic, adhesive friction, or duct tape. The ends shall then be dipped in wax, applying two or more layers.

7. Each tube shall be permanently marked showing which end is at top, project number and site, boring number, sample number, depth at the top and bottom of the sample, penetration and recovery in inches.
8. Care must be used when handling the undisturbed thin-walled tube samples. The tube should always remain in the upright vertical position while they are being handled.
9. The Drilling Subcontractor shall carefully pack samples upright in shipping barrels of a design similar to those shown in Figure 2 (Shipping Barrel). Barrels and packing material shall be provided at the work site by WMCO. Custody of the shipping barrels shall be transferred to WMCO for off-site shipment. Shipping barrels should provide cushioning material (rubber, polystyrene, urethane foam, or material with similar resiliency) that encases each sample to protect it from vibration and shock. Barrels should include sufficient insulating material to prevent freezing, sublimation, thawing, or undesirable temperature changes. (Refer to ASTM D 4220 for further shipping barrel details.)
10. Shipping barrels used to transport thin-walled sample tubes shall be permanently marked to identify project number and site, boring number, sample numbers and sample depths. Packaging tubes from more than one boring in a individual shipping container is acceptable if the barrel is so marked.
11. The sample jar used to store the soil removed from the ends of the thin-walled sample tube handled and transported as described in Section 3.04(E).
12. Sample shipping barrels shall be placed on a pad of resilient material in the vehicle used for transport. The barrel shall be firmly fastened in a manner which does not allow them to bounce against the vehicle sides or other objects.
13. At all times the samples shall be protected from freezing temperatures or excessive heat.

F. Undisturbed Thin-Walled Cohesive Samples

1. Cohesive samples obtained from thin walled samplers shall be preserved, handled and transported in a manner consistent with "Group C" samples described in ASTM D 4220.
2. Any thin-walled tube containing hazardous materials (radioactive, toxic, volatile, or other contaminant) as determined from field screening by WMCO radiological or environmental safety technicians shall be marked with the appropriate instructions, descriptions, warnings, and labels. Special instructions, as appropriate, shall accompany the containers.
3. The only material to be removed from the thin-walled tube shall consist of loose cuttings or washed soil and obviously disturbed material. The sample length shall be measured immediately after removing the disturbed material from the tube.
4. If the undisturbed soil extends to either end of the tube, it shall be removed for a distance of approximately 1 inch and placed into a mason type jar. The jar shall be labeled with project number and site, boring number, sample number, depth at top and bottom of sample, and sample penetration and recovery.
5. The recesses at each end of the tube shall be sealed using wax with disks. For wax with disk sealing, microcrystalline wax or microcrystalline wax with up to 15 percent beeswax or rosin should be used. Metal disks about 1/16-inch-thick and having a diameter sightly less than 3 inches should be used in union with the wax. (prewaxed wood disks 1-inch-thick and having a diameter slightly less than 3 inches may also be used). The recesses at each end of the tube shall be completely filled with the hot, melted sealing wax and allowed to cool. Several thin layers of wax are preferred over one thick layer with two layers being the minimum. The minimum final thickness shall be 0.4 inch.
6. The ends of the tube shall be closed with snug fitting metal, rubber, or plastic end caps. The

14. The WMCO/Parsons Engineer may elect to have WMCO perform handling and transportation of all samples.

G. Undisturbed Thin-Walled Sand Samples

1. Sand samples obtained from thin walled samplers shall be preserved, handled and transported in a manner consistent with "Group C" samples described in ASTM D 4220.
2. Any thin-walled tube containing hazardous materials (radioactive, toxic, volatile, or other contaminant) as determined from field screening by WMCO radiological or environmental safety technicians shall be marked with the appropriate instructions, descriptions, warnings, and labels. Special instructions, as appropriate, shall accompany the containers.
3. The operation of pulling the drill rods should be observed and a note made of any jarring, shock, or other irregularity in bringing the sample tube to the ground surface and detaching it from the sampler.
4. As soon as the undisturbed sample is brought to the ground surface, the bottom of the tube must be cleaned out a sufficient distance to allow placement of a perforated expandable packer. The depth of clean out, measured to an accuracy of 1 mm at three points and the condition of the cutting edge should be noted at this point.
5. The piston arrangement shall be carefully disassembled and separated from the tube avoiding jarring or shaking the tube while keeping the tube always in the vertical, upright position. The thin-walled tube sample shall then be allowed to drain in an upright position.
6. While still in an upright position, any loose material in the upper part of the tube should be cleaned out and the depth to the sample measured to an accuracy of 1 mm and recorded.
7. If the sample is going to be used within 4 to 5 weeks, it is not necessary to place a packer on the upper surface. Alternatively, a small plastic bag

may be filled with damp paper towels, to form a plug and gently be placed on top of the sample. Additional damp paper towels should be placed in the tube and a perforated plastic cap tapped on to the top of the tube to prevent excessive drying of the sample.

8. Each tube shall be permanently marked showing which end is at top, project number and site, boring number, sample number, depth at the top and bottom of the sample, penetration and recovery.
9. Care must be used when handling the undisturbed thin-walled tube samples. The tube should always remain in the upright vertical position while they are being handled.
10. The Drilling Subcontractor shall carefully pack samples upright in shipping barrels of a design similar to those shown in Figure 2 (Shipping Barrel). Barrels and packing material shall be provided at the work site by WMCO. Custody of the shipping barrels shall be transferred to WMCO for off-site shipment. Shipping barrels should provide cushioning material (rubber, polystyrene, urethane foam, or material with similar resiliency) that encases each sample to protect it from vibration and shock. Containers should include sufficient insulating material to prevent freezing, sublimation, thawing, or undesirable temperature changes. (Refer to ASTM D 4220 for further shipping barrel details.)
11. Shipping barrels used to transport thin-walled sample tubes shall be permanently marked to identify project number and site, boring number, sample numbers and sample depths. Packaging tubes from more than one boring in a individual shipping barrel is acceptable if the barrel is so marked.
12. The sample jar used to store the soil removed from the ends of the thin-walled sample tube handled and transported as described in Section 3.04(E).
13. Sample shipping barrels shall be placed on a pad of resilient material in the vehicle used for transport. The barrels shall be firmly fastened in

a manner which does not allow them to bounce against the vehicle sides or other objects.

14. At all times the samples shall be protected from freezing temperatures or excessive heat.
15. The WMCO/Parsons Engineer may elect to have WMCO perform handling and transportation of all samples.

3.05 FIELD CLASSIFICATION OF SOIL STRATA

A. Soils shall be described and recorded in accordance with the following items of classification. The Unified Soil Classification System shall be followed. In general, soils shall be considered either granular or cohesive.

1. Texture
    a. A granular soil shall be considered as either a gravel or a sand. Soils in either category shall be described as coarse, medium or fine grained. The supplementary texture of the granular material shall be given through the use of one adjective.
    b. A cohesive soil shall be considered either as a silt or clay. The supplementary texture of the cohesive material shall be given through the use of one adjective.
    c. The texture of either granular or cohesive soils may be modified to disclose the presence of organic materials. Use such measurements as trace or some to disclose the presence of foreign particles in cohesive soils.
2. State
    a. Granular soils shall be defined in terms of density, as very loose, loose, medium dense, dense, or very dense. Cohesive soils shall be defined in terms of consistency, as very soft, soft, medium stiff, stiff, very stiff or hard.
3. Color
    a. The basic color of a soil, such as yellow, brown, red, gray, blue, or black shall be modified if necessary by adjectives such as light, dark, mottled or mixed.
4. Moisture

a. The amount of moisture present in a soil sample shall be defined in terms of wet, moist or dry.

5. Description Examples

a. The soil description shall be in an ordered sequence. The state shall be described first, followed by color, next texture followed by moisture. Examples of typical descriptions of soil are as follows:

(1) Soft, dark gray, sandy silt, wet;

(2) Dense, yellow, silty fine sand, with some gravel, moist;

(3) Hard, mottled gray, sandy clay, trace organic material, dry.

b. If appropriate, angularity of coarse size soil and/or shape of gravel, cobbles, and boulders shall be included on the field/drillers logs. Odors shall also be described in the log if organic or unusual.

c. For further details one may refer to ASTM D-2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

3.06 GROUNDWATER OBSERVATIONS

A. Observations shall be made of groundwater levels in all completed borings. Any and all unusual water conditions and elevations at which there is a gain or loss of water or return of water after a loss in boring operations shall be noted. Also, observations of elevations under excess water pressure shall be recorded completely in the boring logs. When water under excess pressure is observed, the drilling operation shall be stopped, and casing shall extend above the ground surface so as to contain flow. Once the water level has come to equilibrium, the height of water above the ground surface shall be recorded. Groundwater levels shall be measured before and after pulling casing, where used, and 24 hours later.

3.07 GROUTING OF COMPLETED HOLES

A. The Drilling Subcontractor shall backfill the entire hole with a water-cement-bentonite grout upon completion of each boring. Grout shall meet the requirements specified in Section 2.01.

B. The source of grouting water must be approved by the WMCO/Parsons Engineer.

C. The grout shall be placed by pumping through the drill rods or tremie pipe. The drill rods or tremie pipe shall be lowered to the bottom of the boring and the grout shall then be pumped until all liquid in the borehole has run out the top of the boring as it is displaced by grout. Pumping of grout into the hole shall continue until the grout starts to overflow from the top of the boring.

D. Steel casing, when used in any hole, shall be withdrawn as the hole is grouted.

E. After the grout has hardened and settled, the Drilling Subcontractor shall return to each boring location and add grout as needed so that all boreholes are grouted full to ground surface.

3.08 PIEZOMETERS

A. When the sample boring is drilled without using drilling fluid, the piezometer may, at the option of the WMCO/Parsons Engineer, be placed in the sample boring. Otherwise, the piezometer will be placed in an augured hole offset from the sample boring.

B. When an offset boring is used, it shall be drilled with a continuous flight hollow stem or solid core auger and sampling will not be required.

C. The piezometer boring shall be drilled to the depth directed by the WMCO/Parsons Engineer and shall have a nominal 6-inch diameter.

D. If the boring will not stay open after the auger has been removed, 6-inch-diameter steel casing shall be driven to the full depth, and the soil cleaned from the casing by using a cutting or chopping bit as described in Section 3.01. Clean potable water shall be used to flush the soil out of the casing.

E. Standard 2-inch diameter Schedule 40 or Schedule 80 PVC wellpoint attached to 2-inch diameter Schedule 40 PVC riser pipe shall be screened at the depth selected by the WMCO/Parsons Engineer.

F. As the casing is being withdrawn, the annular space between the wall of the boring and the wellpoint shall be filled with clean concrete sand as directed by the WMCO/Parsons Engineer to a point at least 7 feet above the bottom of the wellpoint. The Drilling Subcontractor shall exercise caution in the extraction of the casing to maintain clean concrete sand within the casing at all times. However, an excessive amount of sand within the casing will bind against the pipe and wellpoint, lifting the wellpoint up with the casing. If the boring is not cased, the above procedure is also used.

G. The boring above this point shall then be sealed with a 3-foot plug of bentonite and shall be grouted to the height directed by the WMCO/Parsons Engineer with a cement-bentonite grout as the casing is withdrawn.

H. All piezometers shall extend not less than 3 feet above the ground surface and in all cases shall be of sufficient length to prevent overflow of groundwater.

I. The WMCO/Parsons Engineer shall inspect and approve each section of pipe before installation. Pipe joint sealer shall be used on all joints.

J. The top of each PVC piezometer shall be provided with threaded PVC cap in which an air hole has been drilled.

K. When each piezometer installation is completed and the grout has set, water shall be either bailed or pumped from the riser to 10 feet or more below the estimated static groundwater level and the depth from the top of pipe to water level measured and recorded. The water level shall again be measured and recorded 48 hours later.

L. The WMCO/Parsons Engineer may elect to have the piezometer flushed clean, rather than bailed, and then filled with water to run a falling head test.
   a. If it is determined that the piezometer is not reacting properly, the drilling subcontractor shall be required to develop the piezometer until it is an active well.

M. Drums or a plastic-lined, aboveground holding structure is required for water removed during piezometer installation and development. Water collected in the holding structure shall be transferred into drums. The water shall be collected in drums for transfer to the FMPC Wastewater Treatment System. WMCO shall be responsible for custody, identification, packaging, transportation, temporary storage, sampling/analysis, disposition, and reporting of drummed water in accordance with WMCO procedures.

N. The number of each piezometer shall be prominently marked with a brass tag securely fastened to the riser pipe and also painted on the pipe. Three heavy gage 7 feet long steel fence posts shall be installed around each completed piezometer. The posts should be spaced 120 degrees apart and 3 feet from the piezometer. Posts should be driven 3 feet into the ground.

3.09 RECORDS AND REPORTS

A. Field Records. During the progress of each boring, the Drilling Subcontractor shall keep a continuous and accurate field record of the operation for each boring. The record shall consist of an accurate log and description of the materials encountered, a record of samples obtained, and a record of the samplers, driving weights, and casing used. One copy of the field record shall be made available to the WMCO/Parsons Engineer at the completion of each day's work. The following data/information (as applicable) shall be included in these reports:

1. General Soil Boring Information (see Section 3.01)
    a. Name of Drilling Subcontractor
    b. Name(s) of drilling rig crew and WMCO/Parsons field engineer
    c. Project number or name of job
    d. Location of site
    e. Type and make of drilling rig and equipment used
    f. Dates and times of beginning and completion of work
    g. Date and time of start and finish of boring
    h. Weather conditions
    i. Identifying number and location of test boring (station and coordinates, if available and applicable)
    j. Ground surface elevation at the boring (if available)
    k. Method of advancing and cleaning the boring
    l. Method of keeping the boring open
    m. Diameter and description of casing
    n. Total length of each size casing
    o. Length of casing extending below ground surface at the completion of boring
    p. Depth at which any change in stratification occurs
    q. Type of drilling fluid used
    r. Date, time, depth of water surface and the drilling depth at the time a loss or gain of drilling fluid is observed

s. Remarks.

2. Standard Penetration Testing and Split-Barrel Sampling (See Section 3.02)
    a. For each sample obtained record:
        (1) Sample number
        (2) Sample depth
        (3) Description/classification of the soil (See Section 3.05)
        (4) Strata changes within the sample and depth at which they occur
        (5) Sampler penetration length
        (6) Sample recovery length (or percentage)
        (7) Number of blows per 6 inch (or partial) penetration
        (8) Radiation and HNu instrument readings
    b. Equipment and method of driving sampler
    c. Type of sampler used
    d. Length and inside diameter of barrel (note use of liners)
    e. Size, type and length of sampling rods
    f. Remarks

3. Undisturbed Thin-Walled Sampling (See Section 3.03.)
    a. For each sample obtained record:
        (1) Sample number
        (2) Sample depth
        (3) Description/classification of soil (See Section 3.05)
        (4) Sampler penetration length
        (5) Sample recovery length (or percentage)
        (6) Radiation and HNu instrument readings.
    b. Description of sampler including size, type of metal and coating
    c. Method of sampler insertion
    d. Hydraulic pressure used for sampling
    e. Any jarring, shock, dropping of drill rods and sampler or other irregularities observed during sampling and detaching
    f. For undisturbed sand samples, clean out depth measured to 1 mm before and after draining

4. Groundwater records (See Section 3.06)
    a. Depth to groundwater level; date and time measured
    b. Any and all unusual water conditions and elevations at which there is a gain or loss of water or return of water after a loss in boring operations; date and time observed
    c. Observations of elevations under excess water pressure, loss or gain of drill water or sudden artesian pressure; date and time observed
    d. Following casing extension and reaching equilibrium water level due to excess pore pressure, record height of water above ground surface; date and time measured.
    e. Groundwater levels shall measured before and after pulling casing, where used, and 24 hours later.
5. Grouting and Piezometer Records (See Sections 3.07 and 3.08)
    a. Quantity of cement, bentonite, water, and grout used
    b. Method used to install grout
    c. Record of materials used and details of the installation of piezometers.

B. Sample and Sample Container Labels and Markings
1. The following summarizes information required for soil samples, and transport/shipment containers:
    a. Sample Jars
        (1) Project number and site
        (2) Boring number
        (3) Sample number
        (4) Date of sample
        (5) Depths at top and bottom of sample
        (6) Number or blows for each 6-inch (or partial) penetration (Split-barrel samples)
        (7) Penetration and recovery (soil ends of thin-walled samples)
        (8) Additional marking, labeling and accompanying instructions as required by WMCO radiological and environmental technicians

(9) Additional markings to indicate that the jar is for archival purposes only and should not be shipped to the laboratory for testing

2. Sample Jar Boxes and Barrels
   a. Project number and site
   b. Boring number
   c. Sample numbers
   d. Sample depths
   e. Additional marking indicating that box or barrel contains samples from more than one borehole
   f. Additional marking, labeling and accompanying instructions as required by WMCO radiological and environmental technicians
   g. Additional markings to indicate that jars contained in the box or barrel are for archival purposes only and should not be shipped to the laboratory for testing
   h. Required DOT shipping markings, label, placards and accompanying instructions as determined by WMCO
3. Thin-Walled Tube Samples
   a. Project number and site
   b. Boring number
   c. Sample number
   d. Date of sample
   e. Depths at top and bottom of sample
   f. Top of sample marked (This End Up)
   g. Penetration and recovery
   h. Additional marking, labeling and accompanying instructions as required by WMCO radiological and environmental technicians
4. Thin-Walled Tube Shipping Barrels
   a. Project number and site
   b. Boring number
   c. Sample numbers
   d. Sample depths
   e. Additional marking indicating that barrel contains samples from more than one borehole
   f. Additional marking, labeling and accompanying instructions as required by WMCO radiological and environmental technicians

g. Additional markings to indicate that tubes contained in the barrel are for archival purposes only and should not be shipped to the laboratory for testing

h. Required DOT shipping markings, label, placards and accompanying instructions as determined by WMCO

END OF SECTION

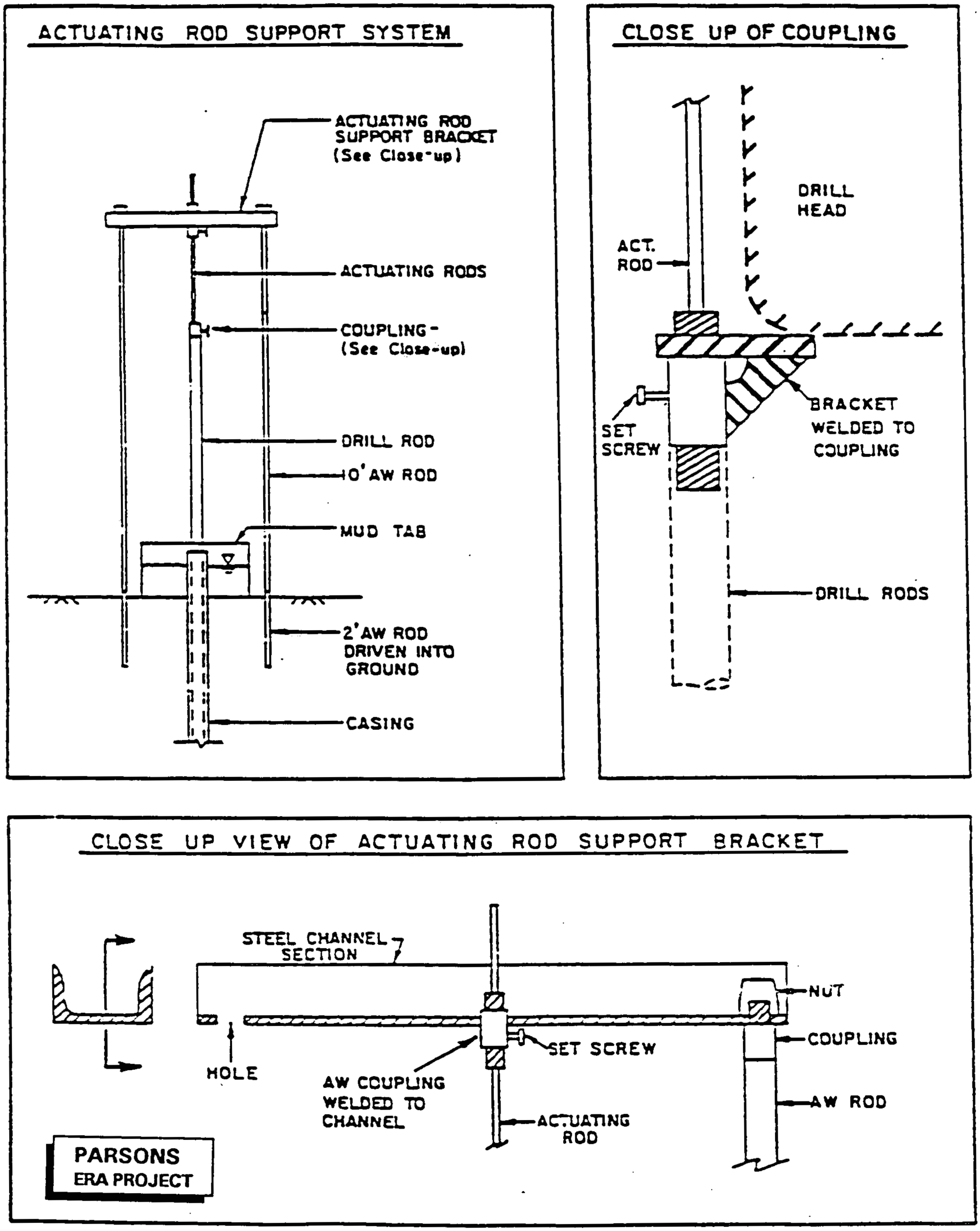
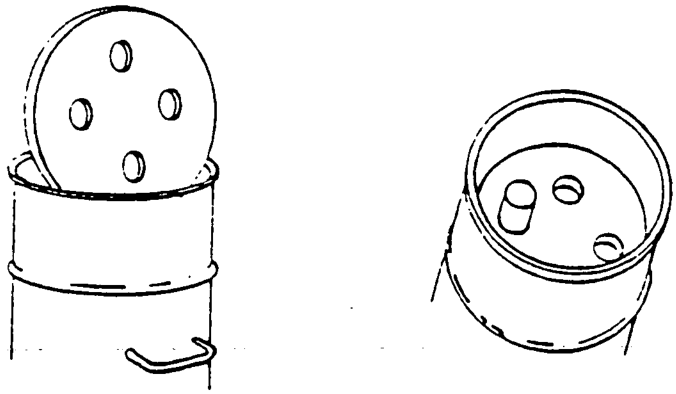
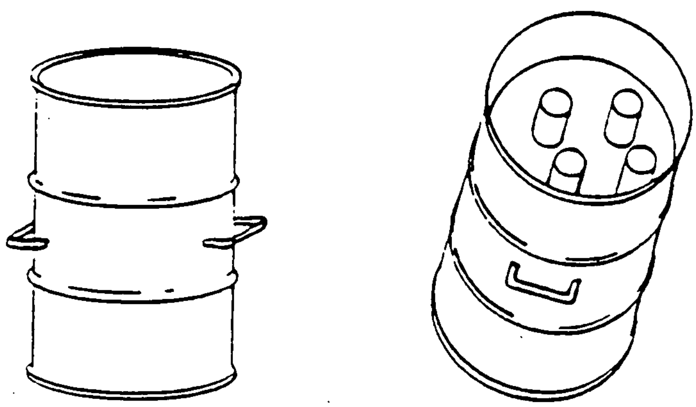


Figure 1 - Elements of Actuating Rod Support System



(a) 55-gallon (0.21 m^3) oil barrels with sections of styrofoam insulation; welded handles on each side.



(b) Same as (a) showing barrel ready for shipment. Steel lids bolted on to provide tight seal.

NOTE—Two in. (51 mm) of foam rubber covers 2 in. of styrofoam at the base. One in. (25 mm) of foam rubber overlays the top of the tubes, and the remaining space to the lid is filled with styrofoam.

(SOURCE: ASTM D 4220 - 83)

Figure 2 - Shipping Barrel for Thin-Walled Tubes

6374-5

ATTACHMENT B

ATTACHMENT B

BORING LOGS

Source: RI/FS Groundwater Report (Draft), December 1990, Appendix A.

CONTENTS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1025	COORDINATES: NORTH 482,021.82 EAST 1,378,309.45	DATE: 12/21/87
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 12/21/87
ENGINEER/GEOLOGIST: B. DUNNING	Depth N/A Date/Time N/A	DATE COMPLETED: 01/08/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE / DATE / TIME	BLOWS / SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	07800 12/21/87 1500	4 16 15	15	DENSE YELLOWISH-BROWN SAND (10YR, 5/4), WET. DENSE LIGHT GRAY GRAVEL ROCK (10YR, 6/1), WET. HARD, DARK BROWN CLAY (10YR, 4/3) WITH SOME COARSE GRAVEL, DRY	SM GW CL	N/A N/A 4.5	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
3.0	07801 12/21/87 1504	50 43 36	9	HARD DARK BROWN CLAY (10YR, 4/3) WITH SOME COARSE GRAVEL, DRY. HARD DARK OLIVE-GRAY CLAY (5Y, 3/2) WITH SOME GRAVEL, DRY. LIGHT GRAY VERY DENSE GRAVEL (10YR, 6/1).	CL CL GP	4.5 4.5+ N/A	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
4.5	07802 12/21/87 1645	10 13 13	18	HARD OLIVE CLAY (5Y, 4/3), DRY.	CL		Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
6.0	07803 12/22/87 1016	31 22 28	18	HARD OLIVE CLAY (5Y, 4/3), DRY. HARD, DARK OLIVE GRAY CLAY (5Y, 3/2) WITH A TRACE OF FINE GRAVEL, DRY.	CL CL	4.5+	Hnu= 0 ppm α = 0 cpm βΓ = 80 cpm
7.5	07804 12/22/87 1021	19 23 30	6	HARD DARK OLIVE GRAY CLAY (5Y, 3/2) WITH A TRACE OF FINE GRAVEL, DRY.	CL	4.5+	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
9.0	07806 12/22/87 1351	13 17 20	15	HARD, OLIVE-GRAY CLAY (5Y, 4/2) WITH A TRACE OF FINE GRAVEL, DRY.	CL	4.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
10.5	07807 12/22/87 1357	25 27 33	18	HARD, OLIVE-GRAY CLAY (5Y, 4/2 WITH A TRACE OF FINE GRAVEL, DRY. STIFF, YELLOWISH-BROWN CLAY (10YR, 5/6) SILTY AND DRY.	CL CL	4.5 1.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
12.0	07808 12/22/87 1625	12 19 22	18	STIFF, YELLOWISH-BROWN CLAY (10YR, 5/6) SILTY AND DRY. HARD, BROWNISH-YELLOW CLAY (10YR, 6/8) WITH A TRACE OF FINE GRAVEL, DRY.	CL CL	1.5 4.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
13.5	07809 12/23/87 0826	5 7 11	12	VERY STIFF, YELLOWISH-BROWN CLAY (10YR, 5/4) TO (10YR, 5/8) WITH A TRACE OF GRAVEL, DRY.	CL	3.5	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
15.0	07810 12/23/87 0840	17 26 27	18	VERY STIFF, YELLOWISH-BROWN CLAY (10YR, 5/4) TO (10YR, 5/8) WITH A TRACE OF GRAVEL, DRY.	CL	3.5	Hnu= 0 ppm α = 0 cpm βΓ = 40-60 cpm

NOTES:
SAMPLES COLOR BY MUNSELL COLOR CHART AND BLOW COUNTS VIA ASTM.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1025	COORDINATES: NORTH 482,021.82 EAST 1,378,309.45	DATE: 12/21/87
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 12/21/87
ENGINEER/GEOLOGIST: B. DUNNING	Depth N/A Date/Time N/A	DATE COMPLETED: 01/08/88
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS	SYMBOL	TSF	REMARKS
16.5	07811 12/23/87 0935		14	SHELBY TUBE PUSHED.				Hnu= 0 ppm α = 0 cpm βγ = 60-80 cpm
18.0	07812 01/07/88 0945	18 18 22	14	HARD, BROWNISH YELLOW CLAY, W/TRACE OF GRAVEL (5Y, 6/6) SLIGHTLY MOIST AT 18 FT.	CL		4.5	Hnu= 0 ppm α = 0 cpm βγ = 60 cpm
19.5	07813 01/07/88 1010	29 22 27	12	HARD, BROWNISH YELLOW CLAY, W/TRACE OF GRAVEL (5Y, 6/6) SLIGHTLY MOIST AT 18 FT.	CL		4.5	Hnu= 0 ppm α = 0 cpm βγ = 50 cpm
21.0	07814 01/07/88 1350	12 17 18	12	STIFF, DARK GRAY CLAY (10YR, 4/1), TRACE OF GRAVEL, MOIST.	CL		1.5	Hnu= 0 ppm α = 0 cpm βγ = 60-80 cpm
22.5	07815 01/07/88 1500	3 4 3	14	STIFF, DARK GRAY CLAY (10YR, 3/1) TRACE OF GRAVEL.	CL			Hnu= 0 ppm α = 0 cpm βγ = 80 cpm

BOTTOM OF BORING 23

NOTES:
SAMPLES COLOR BY MUNSELL COLOR CHART AND BLOW COUNTS VIA ASTM.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1028	COORDINATES: NORTH 481,821.60 EAST 1,378,158.07	DATE: 01/10/88
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/10/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 01/14/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	07817 01/10/88 0930	27 24 17	14	HARD YELLOWISH BROWN SILT (10YR, 5/4), DRY.	ML	4.5	Hnu= 0 ppm α = 0 cpm βΓ = 0 cpm
3.0	07818 01/10/88 0945	11 10 7	12	VERY STIFF, YELLOWISH BROWNISH SILT WITH TRACE GRAVEL (10YR, 5/4), DRY.	ML	2.5	Hnu= 0 ppm α = 0 cpm βΓ = 0 cpm
4.5	07819 01/10/88 0955	16 29 27	6	SILT SIZE FLY ASH, DRY (2.5Y, 2/0) BRITTLE.	ML	N/A	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
6.0	07820 01/10/88 1008	18 18 18	12	SILT SIZE FLY ASH, DRY (2.5Y, 2/0) BRITTLE. HARD, DARK BROWN CLAY (10YR, 4/3) TRACE OF GRAVEL, DRY.	ML CL	N/A 4.5	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
6.5	07823 01/11/88 1300			SHELBY TUBE.			
7.5	07821 01/10/88 1015	18 22 21	18	VERY STIFF DARK BROWN CLAY (10YR, 4/3) TRACE OF GRAVEL, DRY.	CL	3.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
9.0	07822 01/10/88 1020	16 14 14	18	VERY STIFF DARK BROWN CLAY (10YR, 4/3) TRACE OF GRAVEL, DRY. VERY STIFF DARK BROWN CLAY (10YR, 4/3) WITH ORGANIC DEBRIS, DRY.	CL OL	3.5 2.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
10.5	07824 01/11/88 1415	3 5 6	18	VERY STIFF DARK BROWN CLAY (10YR, 4/3) WITH TRACE OF GRAVEL, MOIST.	CL	3.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
12.0	07825 01/11/88 1430	13 11 3	18	VERY STIFF DARK BROWN CLAY (10YR, 4/3) WITH TRACE OF GRAVEL, ENCOUNTERED LIME SLUDGE AT 12 FT., MOIST.	CL	2.5	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
13.5	07826 01/11/88 1440	7 9 13	14	VERY STIFF DARK BROWN CLAY (10YR, 4/3), TRACE OF GRAVEL, MOIST	CL	3.0	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
15.0	07827 01/11/88 1445	13 17 19	18	HARD DARK GREY CLAY (10YR, 4/1) W/GRAVEL. TRACE OF LIME SLUDGE AT 13.5 FT., MOIST.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm

NOTES:
SAMPLES VIA MUNSELL COLORS, ASTM.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1028	COORDINATES: NORTH 481,821.60 EAST 1,378,158.07	DATE: 01/10/88
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/10/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 01/14/88
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE / DATE / TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.8	07828 01/11/88 1630		1.8	SHELBY TUBE.			Hnu= 0 pp α = 0 cp βΓ = 120 cp
17.0							
18.5	07829 01/12/88 0830	6 11 50	12	HARD GRAY CLAY WITH TRACE OF GRAVEL (2.5Y, 5/0), DRY.	CL	4.0	Hnu= 0 pp α = 0 cp βΓ = 100 cp
20.0	07830 01/12/88 0906	12 14 15	12	HARD DARK GRAY CLAY (10YR, 4/1) WITH GRAVEL, DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
21.5	07831 01/12/88 0928	7 11 7	12	HARD DARK GREY CLAY (10YR, 4/1) W/GRAVEL, DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
23.0	07832 01/12/88 0955	8 13 18	10	HARD YELLOWISH BROWN CLAY (10YR, 5/4) TRACE OF GRAVEL, DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
24.5	07833 01/12/88 1025	13 18 26	18	HARD YELLOWISH BROWN CLAY (10YR, 5/4), TRACE OF GRAVEL, DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
26.0	07834 01/12/88 1038	8 3 11	10	HARD YELLOWISH BROWN CLAY (10YR, 5/4), TRACE OF GRAVEL WITH LENSE OF DARK GRAY CLAY AT 25 FEET (10YR, 5/4), DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
27.5	07835 01/12/88 1306	16 18 21	18	HARD YELLOWISH BROWN CLAY (10YR, 5/4) TRACE OF GRAVEL W/LENS OF DARK GREY CLAY AT 25 FT. (10YR, 5/4), DRY. DENSE YELLOWISH BROWN SAND (10YR 5/6) DRY, TRACE OF GRAVEL.	CL SW	4.0 2.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
29.0	07836 01/12/88 1420	8 10 16	8	VERY STIFF DARK GRAY CLAY (10YR, 4/1), MOIST.	CL	3.5	Hnu= 0 ppm βΓ = 80 cpm
30.5	07837 01/12/88 1450	9 17 29	14	VERY STIFF DARK GRAY CLAY (10YR, 4/1), MOIST.	CL	3.25	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm

BOTTOM OF BORING 31

NOTES:
SAMPLES VIA MUNSELL COLORS, ASTM.

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PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1031	COORDINATES: NORTH 481,167.08 EAST 1,378,136.55	DATE: 04/05/88
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/05/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 04/07/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 2

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	08832 04/05/88 0915	2 9 13	10	HARD VERY DARK GRAYISH BROWN CLAY (10YR, 3/2), DRY.	CL	>4	Hnu= 0 ppm α = 0 cpm βΓ = 260 cpm
3.0	08833 04/05/88 0920	6 6 8	12	HARD DARK BROWN CLAY (10YR, 4/3), DRY.	CL	>4	Hnu= 0 ppm α = 0 cpm βΓ = 260 cpm
4.5	08834 04/05/88 0925	21 10 11	12	VERY STIFF DARK BROWN CLAY (10YR, 4/3) DRY.	CL	>4	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm
6.0	08835 04/05/88 0930	9 11 7	10	VERY STIFF DARK BROWN CLAY (10YR, 4/3), DRY. MEDIUM STIFF GRAY CLAY (5Y, 5/1), MOIST, TRACE GRAVEL.	CL CL	>4 <1	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm
7.5	08836 04/05/88 0935	8 11 7	10	MEDIUM STIFF DARK BROWN CLAY (10YR, 4/3), MOIST.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 220 cpm
9.0	08837 04/05/88 0937	9 11 12	12	MEDIUM STIFF GRAY CLAY (5Y, 5/1) DRY, TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 210 cpm
10.5	08839 08838 04/05/88 0940	16 11 13	18	MEDIUM STIFF, GRAY CLAY (5Y, 5/1) DRY, TRACE GRAVEL. MEDIUM STIFF, YELLOWISH BROWN CLAY (10YR, 5/8) MOIST, TRACE GRAVEL.	CL CL	<1 <1	Hnu= 0 ppm α = 0 cpm βΓ = 210 cpm
12.0	08840 04/05/88 1400	4 5 9	18	MEDIUM STIFF OLIVE GRAY CLAY (5Y, 4/2) DRY, TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 210 cpm
13.5	08841 04/05/88 1410	5 7 11	18	MEDIUM STIFF OLIVE GRAY CLAY (5Y, 4/2) DRY, TRACE GRAVEL. MEDIUM STIFF VERY DARK GRAY (2.5Y, 3/0) TRACE GRAVEL.	CL CL	<1 <1	Hnu= 0 ppm α = 0 cpm βΓ = 210 cpm
15.0	08842 04/05/88 1415	7 5 12	10	MEDIUM STIFF OLIVE GRAY CLAY (5Y, 4/2) DRY, TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 210 cpm

NOTES:
COLOR VIA MUNSELL COLOR CHART

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1031	COORDINATES: NORTH 481,167.08 EAST 1,378,136.55	DATE: 04/05/88
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/05/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 04/07/88
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 2

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.5	08843 04/05/88 1500	4 5 11	18	MEDIUM STIFF DARK GRAY CLAY (5Y, 4/1) DRY, TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm
18.0	08844 04/05/88 1510	4 10 10	16	MEDIUM STIFF DARK GRAY CLAY (5Y, 4/1) DRY, TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm
19.5	08845 04/05/88 1645		18	SHELBY TUBE.			
21.0	08846 04/07/88 0930	2 2 2	8	MEDIUM STIFF YELLOWISH BROWN CLAY (10YR, 5/6) TRACE GRAVEL.	CL	<1	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm
22.5	08847 04/07/88 0940	5 4 7	10	STIFF DARK YELLOWISH BROWN CLAY (10YR, 4/6), TRACE GRAVEL, DRY	CL	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
24.0	08848 04/07/88 0955	16 13 14	6	STIFF DARK YELLOWISH BROWN CLAY (10YR, 5/6), TRACE GRAVEL. TRACE GRAY CLAY (5Y, 5/1).	CL	1.5	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
25.5	08849 04/07/88 1040	15 22 50	18	VERY DENSE DARK BROWN SANDY SILT (10YR, 4/3) DRY, NO CLAY.	SM	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
27.0	08850 04/07/88 1055	14 32 36	18	VERY DENSE DARK BROWN SANDY SILT (10YR, 4/3) DRY, NO CLAY. VERY HARD YELLOWISH BROWN CLAY WITH SILT (10YR, 4/8) DRY, TRACE GRAVEL.	SM CL	4.0 4.0	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
28.5	08851 04/07/88 1300	16 22 37	18	VERY HARD GRAYISH BROWN CLAY (2.5Y, 5/2) DRY, TRACE GRAVEL.	CL	>4.0	Hnu= 0 ppm α = 0 cpm βΓ = 240 cpm
30.0	08852 04/07/88 1315	20 22 17	18	VERY HARD GRAYISH BROWN CLAY (2.5Y, 5/2) DRY, TRACE GRAVEL. DENSE YELLOWISH BROWN SAND (10YR, 5/8), DRY.	CL SW	>4.0 <1	Hnu= 0 ppm α = 0 cpm βΓ = 200 cpm

BOTTOM OF BORING 30

NOTES:
COLOR VIA MUNSELL COLOR CHART

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6374 -

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1079	COORDINATES: NORTH 482,273.70 EAST 1,378,165.47	DATE: 10/19/87
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 10/19/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 10/21/87
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 3

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	07369 10/19/87 1035	5 13 17	13	YELLOWISH BROWN SILT, TRACE SAND AND CLAY AND GRAVEL - DRY. HARD, VERY PALE BROWN CLAY, SILT, TRACE SAND - DRY.	ML CL	4.5+ 4.5+	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
3.0	07370 10/19/87 1045	26 24 33	18	HARD, LIGHT YELLOWISH BROWN CLAY AND SILT, TRACE SAND - DRY.	CL	4.5+	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
4.5	07371 10/19/87 1050	50	4	HARD, LIGHT YELLOWISH BROWN CLAY, SOME SILT AND GRAVEL, TRACE SAND, DRY.	CL	4.5+	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
6.0	07372 10/19/87 1520	8 11 13	14	MEDIUM STIFF GRAY SILT, TRACE CLAY AND SAND - DRY. MEDIUM STIFF LIGHT YELLOWISH BROWN CLAY, TRACE SILT, GRAVEL, AND SAND - DRY.	ML CL	4.5+ 3.5	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
7.5	07373 10/19/87 1600	6 8 15	12	GRAY GRAVEL AND SILT, TRACE SAND AND CLAY. MEDIUM STIFF GRAY SILT, TRACE CLAY AND SAND - DRY.	GM ML	3.5 N/A	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
9.0	07374 10/19/87 1615	6 8 13	14	MEDIUM STIFF GRAY SILT, SOME CLAY, TRACE GRAVEL AND SAND - DRY MEDIUM STIFF OLIVE CLAY, SOME SILT - DRY.	ML CL	2.0	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
10.5	07375 10/19/87 1645	5 6 8	16	STIFF YELLOWISH RED CLAY, TRACE SILT, DRY WOOD FRAGMENTS. STIFF GRAY SILT, SOME CLAY - MOIST. LIGHT YELLOWISH BROWN SILT, TRACE SAND AND CLAY.	CL ML ML	1.25 .1 .1	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
12.0	07376 10/19/87 1700	5 6 8	18	LIGHT YELLOWISH BROWN SILT, TRACE SAND AND CLAY. STIFF REDDISH YELLOW CLAY - TRACE SILT AND SAND - DRY. GRAY CLAY, SOME SILT, TRACE SAND - DRY.	ML CL CL	.1 1.75	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
13.5	07377 10/19/87 1730	2 10 18	10	OLIVE GRAY SILT, TRACE GRAVEL AND SAND - MOIST. MEDIUM DENSE, OLIVE YELLOW SAND, SOME GRAVEL, SOME CLAY, TRACE SILT.	ML SC	N/A .2	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
15.0	07378 10/19/87 1800	8 10 15	12	PALE OLIVE CLAY, TRACE SILT, GRAVEL, SAND - MOIST. VERY STIFF, LIGHT YELLOWISH BROWN GRAVEL, SOME CLAY, TRACE SILT AND SAND - MOIST. LIGHT OLIVE BROWN CLAY, SOME SILT, TRACE SILT - MOIST.	CL GC CH	N/A N/A	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm

NOTES:
MUNSELL 5Y 6/3, SAMPLE SCANNED AT BACKGROUND.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1079	COORDINATES: NORTH 482,273.70 EAST 1,378,165.47	DATE: 10/19/87
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 10/19/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 10/21/87
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 3

DEPTH	SAMPLE / DATE / TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.5	07379 10/19/87 1830	10 16 27	12	GRAY CLAY, SOME GRAVEL, TRACE SAND AND SILT, DRY. HARD, GRAY CLAY, SOME GRAVEL, TRACE SILT AND SAND, MOIST.	CL CL	1.25 1.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
18.0	07381 10/20/87 0940	2 7 13	18	VERY STIFF, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST.	CH	.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
18.5	07380 10/20/87 0915			SHELBY TUBE.	CH	.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
19.5	07382 10/20/87 1010	2 6 10	5	VERY STIFF, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST.	CL	2.0	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
21.0	07383 10/20/87 1030	10 12 20	13	HARD, LIGHT GRAYISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - WET.	CL	1.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
22.5	07384 10/20/87 1045	8 5 10	3	STIFF LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SILT AND SAND - WET.	CH	N/A	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
24.0	07385 10/20/87 1115	4 6 9	15	STIFF, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - WET.	CH	1.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
25.5	07386 10/20/87 1320	4 6 15	10	STIFF, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CH	1.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
27.0	07387 10/20/87 1335	5 20 48	13	STIFF, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - WET. VERY DENSE, GRAY GRAVEL, SOME SAND, TRACE CLAY AND SILT - MOIST.	CH GC	1.0 N/A	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
28.5	07388 10/20/87 1400	39 20 29	15	DENSE, LIGHT YELLOWISH BROWN GRAVE, SOME SAND, TRACE CLAY - WET. HARD, LIGHT YELLOWISH BROWN CLAY, TRACE GRAVEL, SAND, AND SILT - MOIST.	GC CL	N/A 4.5	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm
30.0	07389 10/20/87 1520	10 17 35	15	HARD, LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL AND SILT, TRACE SAND - MOIST.	CL	4.5	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40-80 cpm

NOTES:
MUNSELL 2.5Y 6/2

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1079	COORDINATES: NORTH 482,273.70 EAST 1,378,165.47	DATE: 10/19/87
GROUND ELEVATION:	GWL: Depth N/A Date/Time N/A	DATE STARTED: 10/19/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 10/21/87
DRILLING METHODS: CABLE-TOOL		PAGE 3 OF 3

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
31.5	07390 10/20/87 1530	12 22 32	17	LIGHT YELLOWISH BROWN CLAY, SOME GRAVEL, TRACE SAND AND SILT - DRY. HARD OLIVE CLAY, SOME GRAVEL, AND SILT, TRACE SAND - DRY.	CL CL	4.5	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
33.0	07391 10/20/87 1600	11 50	12	OLIVE CLAY, SOME GRAVEL, TRACE SILT AND SAND - DRY. HARD, LIGHT BROWNISH GRAY SILT, SOME SAND - MOIST.	CL ML	4.5 2.0	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
34.5	07392 10/20/87 1615	20 28 30	18	HARD LIGHT BROWNISH GRAY SILT, SOME SAND, TRACE GRAVEL - MOIST HARD OLIVE CLAY, SOME FINE GRAVEL, TRACE SILT AND SAND.	ML CL	2.5 4.5	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
36.0	07393 10/20/87 1645	9 17 27	18	HARD OLIVE CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST.	CL	4.25	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
37.5	07394 10/20/87 1700	9 10 13	13	VERY STIFF, OLIVE SILT, TRACE CLAY - WET. OLIVE SILT, SOME CLAY - WET.	ML ML	1.25 1.25	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm
39.0	07395 10/20/87 1810	8 18 30	15	OLIVE SILT, SOME CLAY, TRACE SAND - WET. HARD BROWNISH YELLOW SILT, SOME CLAY - MOIST. DENSE YELLOWISH BROWN SAND, TRACE SILT.	ML ML SW	1.25 3.5 1.5	Hnu= 0 ppm α = 0 cpm βΓ = 40-80 cpm

BOTTOM OF BORING 39.0

NOTES:
MUNSELL 5Y 5/3, MUNSELL 10YR 6/8, MUNSELL 10YR 5/6

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1080	COORDINATES: NORTH 482,229.86 EAST 1,378,630.45	DATE: 04/26/88
GROUND ELEVATION: 581.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 04/28/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 4

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	08780 04/26/88 0918	3 7 5	6	M. DENSE, VERY PALE BROWN (10YR, 8/4) GRAVELLY SAND, FILL, DRY			Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
3.0	08781 04/26/88 0924	4 5 6	4	VERY STIFF, DARK YELLOWISH BROWN (10YR, 4/4) CLAY, SOME SILT, MOIST.	CL		Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
4.5	08782 04/26/88 0928	5 9 11	12	VERY STIFF, DARK BROWN (10YR, 3/3) SILTY CLAY, TRACE SAND, TRACE GRAVEL, MOIST.	CL	3.7	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
6.0	08783 04/26/88 0933	8 10 14	13	VERY STIFF, DARK YELLOWISH BROWN (10YR, 4/4) WITH GRAY MOTTLED SILTY CLAY, TRACE GRAVEL, TRACE SAND, MOIST.	CL	2.7	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
7.5	08784 04/26/88 0940	14 17 19	13	VERY STIFF, VERY DARK BROWN (10YR, 2/2) SILTY CLAY, TRACE GRAVEL, TRACE SAND, MOIST.	CL	3.3	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
9.0	08785 04/26/88 1118	5 11 15	14	VERY STIFF, DARK GRAY (2.5Y, 4/0) CLAY, SOME SILT, TRACE GRAVEL, TRACE SAND, MOIST.	CL	3.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
10.5	08786 04/26/88 1142	2 10 17	12	VERY STIFF, VERY DARK GRAY (2.5Y, 3/0) CLAY, SOME SILT, TRACE SAND, MOIST.	CL	2.8	Hnu= 0 ppm α = 2 cpm βΓ = 55 cpm
12.0	08787 04/26/88 1327		12	SHELBY TUBE.. PUSHED SHELBY 1.5 FT., 1.0 FT. RECOVERY.			
13.5	08788 04/26/88 1339	16 24 32	18	HARD, YELLOWISH BROWN (10YR, 5/6) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	4.1	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
15.0	08789 04/26/88 1355	4 14 25	9	VERY STIFF, BROWNISH YELLOW (10YR, 6/8) SILTY CLAY, TRACE SAND AND GRAVEL, DRY.	CL	2.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm

NOTES:
SOIL SAMPLING AS PER ASTM. COLOR DESCRIPTION AS PER MUNSELL.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1080	COORDINATES: NORTH 482,229.86 EAST 1,378,630.45	DATE: 04/26/88
GROUND ELEVATION: 581.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 04/28/88
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 4

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.5	08790 04/26/88 1416	9 34 14	16	HARD, YELLOWISH BROWN (10YR, 5/4) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	>4.5	Hnu= 0 ppm α = 2 cpm βΓ = 60 cpm
18.0	08791 04/26/88 1430	3 8 11	12	VERY STIFF, GRAY (2.5Y, 5/0) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	2.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
19.5	08792 04/26/88 1450	4 8 13	17	STIFF, DARK GRAY (2.5Y, 4/0) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	1.6	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
21.0	08793 04/26/88 1501	2 5 8	14	STIFF, GRAY (2.5Y, 5/0) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	1.6	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
22.0							
23.5	08668 04/26/88 1629	8 10 15	13	STIFF, GRAY (2.5Y, 5/0) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL	1.1	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
25.5	08794 04/26/88 1715		21	SHELBY TUBE.. PUSHED SHELBY 2.0 FT., 1.75 FT. RECOVERY..			
27.0	08795 04/27/88 0743	5 9 40	5	STIFF, GRAY (2.5Y, 5/0) SILTY CLAY, SOME GRAVEL, TRACE SAND, MOIST.	CL	1.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
28.5	08797 08798 04/27/88 0805	12 36 58	14	HARD, DARK GRAY (2.5Y, 4/0) SILTY CLAY, SOME GRAVEL, TRACE SAND, MOIST.	CL	>4.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
28.5	08796 04/27/88 0805	12 36 58	14	HARD, DARK GRAY (2.5Y, 4/0) SILTY CLAY, SOME GRAVEL, TRACE SAND, MOIST.	CL	>4.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
30.0	08799 04/27/88 0833	15 50 50	16	HARD, GRAY (2.5Y, 5/0) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST. V. DENSE, GRAY 2.5Y, 5/0 FINE SAND, SOME SILT. HARD, DARK GRAY (5Y, 4/1) SANDY SILT, SOME CLAY, MOIST.	CL SW ML	>4.5 N/A >4.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm

NOTES:
SOIL SAMPLING AS PER ASTM. COLOR DESCRIPTIONS AS PER MUNSELL.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1080	COORDINATES: NORTH 482,229.86 EAST 1,378,630.45	DATE: 04/26/88
GROUND ELEVATION: 581.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 04/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 04/28/88
DRILLING METHODS: CABLE-TOOL		PAGE 3 OF 4

DEPTH	SAMPLE DATE TIME	BLOWS SAMPLE OR CORE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
31.5	08800 04/27/88 0857	38 50	10	HARD, DARK GRAY (5Y, 5/1) SANDY SILT, SOME CLAY, MOIST. VERY STIFF, DARK GRAY (5Y,4/1) CLAY, SOME SILT, TRACE SAND AND GRAVEL, MOIST.	ML CL	>4.5 3.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
33.0	08801 04/27/88 0958	14 24 29	18	VERY STIFF, DARK GRAY (5Y, 4/1) CLAY, SOME SILT, TRACE SAND AND GRAVEL, MOIST.	CL	3.5	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
34.5	08802 04/27/88 1015	5 11 18	4	DARK GRAY (5Y, 4/1) CLAY, SOME SILT AND GRAVEL, MOIST.	CL		Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
36.0	08803 04/27/88 1027	5 9 12	17	VERY STIFF, DARK GRAY (5Y, 4/1) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST.	CL		Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
37.5	08804 04/27/88 1042	7 21 27	15	VERY STIFF, DARK GRAY (5Y, 4/1) SILTY CLAY, TRACE SAND AND GRAVEL, MOIST. HARD, BROWNISH YELLOW (10YR, 6/8) SILTY CLAY, MOIST. VERY DENSE, VERY PALE BROWN (10YR, 7/4) FINE SAND, WELL SORTED, TRACE SILT, DRY.	CL CL SW	2.1 >4.5 N/A	Hnu= 0 ppm α = 2 cpm βΓ = 50 cpm
40.0							
41.5	08665 04/27/88 1100	16 36 50	16	VERY DENSE, VERY PALE BROWN (10YR, 7/4) FINE SAND, WELL SORTED, TRACE SILT, SLIGHTLY MOIST.	SW	N/A	Hnu= 0 ppm α = 2 cpm βΓ = 50 cpm
45.0							

NOTES:
SOIL SAMPLING AS PER ASTM. COLOR DESCRIPTIONS AS PER MUNSELL.

000084

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 1080	COORDINATES: NORTH 482,229.86 EAST 1,378,630.45		DATE: 04/26/88
GROUND ELEVATION: 581.7	GWL: Depth N/A	Date/Time N/A	DATE STARTED: 04/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A	Date/Time N/A	DATE COMPLETED: 04/28/88
DRILLING METHODS: CABLE-TOOL			PAGE 4 OF 4

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
46.5	08666 04/27/88 1258	35 49 44	18	VERY DENSE, VERY PALE BROWN (10YR, 7/4) FINE SAND, TRACE MED. SAND TO FINE GRAVEL, TRACE SILT, SLIGHTLY MOIST.	SW	N/A	Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm
50.0							
51.5	08667 04/27/88 1411	22 33 50	17	VERY DENSE, BROWNISH YELLOW (10YR, 6/6) FINE SAND, TRACE MED. SAND TO FINE GRAVEL, TRACE SILT, MOIST.			Hnu= 0 ppm α = 2 cpm βΓ = 40 cpm

BOTTOM OF BORING 51.5

NOTES:
SOIL SAMPLING AS PER ASTM. COLOR DESCRIPTIONS AS PER MUNSELL.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1081	COORDINATES: NORTH 482,041.23 EAST 1,379,003.69	DATE: 12/01/87
GROUND ELEVATION: 590.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 12/01/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 12/03/87
DRILLING METHODS: CABLE-TOOL		PAGE 3 OF 3

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
31.5	07654 12/02/87 1540	4 7 10	14	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CH	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 60 cpm
33.0	07655 12/02/87 1555	3 7 9	14	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, SOME GRAVEL, TRACE SAND AND SILT - MOIST.	CH	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 50 cpm

BOTTOM OF BORING 33.0

NOTES:
SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST. COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1081	COORDINATES: NORTH 482,041.23 EAST 1,379,003.69	DATE: 12/01/87
GROUND ELEVATION: 590.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 12/01/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 12/03/87
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 3

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	07633 12/01/87 0850	5 6 6	12	STIFF BROWN (10YR, 5/3) SILT, TRACE CLAY AND SAND - DRY. STIFF LIGHT GRAY (5Y, 6/1) SILT, SOME CLAY, TRACE GRAVEL AND SAND - DRY.	ML ML	3.0 3.5	Hnu= 0 ppm α = 0 cpm BΓ = 60 cpm
3.0	07634 12/01/87 0920	4 9 19	14	VERY STIFF LIGHT GRAY (5Y, 6/1) SILT, SOME CLAY AND GRAVEL - DRY.	ML	4.0	Hnu= 0 ppm α = 0 cpm BΓ = 50 cpm
4.5	07635 12/01/87 1000	12 16 17	15	VERY STIFF LIGHT GRAY (5Y, 6/1) SILT, SOME CLAY AND GRAVEL - DRY. HARD YELLOWISH BROWN (10YR, 5/4) CLAY, SOME SAND AND SILT, TRACE FINE GRAVEL - DRY. HARD PALE BROWN (10YR, 6/3) CLAY, SOME SAND, TRACE SILT - DRY.	ML CL CL	4.0 4.0 3.5	Hnu= 0 ppm α = 0 cpm BΓ = 70 cpm
6.0	07636 12/01/87 1015	12 12 8	11	VERY STIFF BROWNISH YELLOW (10YR, 6/4) CLAY, SOME SAND, TRACE GRAVEL AND SILT - DRY.	CL	2.25	Hnu= 0 ppm α = 0 cpm BΓ = 70 cpm
7.5	07637 12/01/87 1050	4 5 4	14	VERY STIFF BROWNISH YELLOW (10YR, 6/4) CLAY, SOME SAND, TRACE GRAVEL AND SILT - DRY. STIFF LIGHT YELLOWISH BROWN (10YR, 6/4) CLAY, SOME SILT - MOIST. S	CL CL CL	2.25 1.0 2.5	Hnu= 0 ppm α = 0 cpm BΓ = 50 cpm
9.0	07638 12/01/87 1100	6 6 7	13	STIFF BROWN (10YR, 5/4) CLAY, SOME SILT, TRACE SAND AND GRAVEL - DRY.	CL	2.5	Hnu= 0 ppm α = 0 cpm BΓ = 60 cpm
10.5	07639 12/01/87 1450	9 9 13	14	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SAND AND SILT - MOIST.	CL	2.5	Hnu= 0 ppm α = 0 cpm BΓ = 40 cpm
12.0	07640 12/01/87 1510	5 7 9	15	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SAND AND SILT, TRACE GRAVEL - MOIST. VERY STIFF DARK GRAYISH BROWN (2.5Y, 4/2) SILT, SOME CLAY, TRACE SAND - DRY.	CL ML	2.5 N/A	Hnu= 0 ppm α = 0 cpm BΓ = 40 cpm
13.5	07641 12/01/87 1525	7 9 10	4	VERY STIFF DARK GRAYISH BROWN (2.5Y, 4/2) SILT, SOME CLAY, TRACE SAND - DRY. VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4)	ML	N/A	Hnu= 0 ppm α = 0 cpm BΓ = 40 cpm
15.0	07642 12/01/87 1550	3 7 9	9	VERY STIFF YELLOWISH BROWN (10YR, 5/4) SILTY CLAY, TRACE GRAVEL AND SAND - MOIST.	CL	2.25	Hnu= 0 ppm α = 0 cpm BΓ = 50 cpm

NOTES:
SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST. COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 1081	COORDINATES: NORTH 482,041.23 EAST 1,379,003.69	DATE: 12/01/87
GROUND ELEVATION: 590.7	GWL: Depth N/A Date/Time N/A	DATE STARTED: 12/01/87
ENGINEER/GEOLOGIST: D. OAKLEY	Depth N/A Date/Time N/A	DATE COMPLETED: 12/03/87
DRILLING METHODS: CABLE-TOOL		PAGE 2 OF 3

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.5	07644 12/02/87 0950	4 7 10	8	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME GRAVEL AND SILT, TRACE SAND - MOIST.	CL	1.25	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 30 cpm
17.0	07643 12/02/87 0900			SHELBY TUBE.			
18.0	07645 12/02/87 1000	3 4 10	10	STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - MOIST.	CL	1.5	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm
19.5	07646 12/02/87 1030	5 12 18	15	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, TRACE FINE GRAVEL AND SAND - MOIST.	CL	3.0	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 50 cpm
21.0	07647 12/02/87 1050	3 12 18	14	VERY STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME SILT, SAND, AND FINE GRAVEL - MOIST.	CL	2.75	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 50 cpm
22.5	07648 12/02/87 1115	5 14 27	16	HARD LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME GRAVEL, SILT, AND SAND - MOIST.	CL	4.0	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 60 cpm
24.0	07649 12/02/87 1320	3 5 8	6	STIFF LIGHT YELLOWISH BROWN (2.5Y, 6/4) CLAY, SOME GRAVEL, SILT, AND SAND - MOIST.	CL	2.0	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm
25.5	07650 12/02/87 1345	4 10 13	11	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, SOME SAND AND SILT, TRACE FINE GRAVEL - MOIST.	CL	1.0	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm
27.0	07651 12/02/87 1400	2 8 12	14	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, TRACE SILT, SAND AND FINE GRAVEL - MOIST.	CH	.75	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm
28.5	07652 12/02/87 1445	1 4 7	5	STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, SOME GRAVEL, TRACE SILT AND SAND - MOIST.	CH	.75	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm
30.0	07653 12/02/87 1500	5 7 9	13	VERY STIFF GRAYISH BROWN (2.5Y, 5/2) CLAY, TRACE SAND, GRAVEL, AND SILT - MOIST.	CH	.5	Hnu= 0 ppm α = 0 cpm $\beta\gamma$ = 40 cpm

NOTES:
SAMPLES TAKEN USING ASTM STANDARD PENETRATION TEST. COLORS CLASSIFIED USING MUNSELL COLOR CHARTS.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 1 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
1.5	07910 01/20/88 1005	1 3 4	10	VERY STIFF YELLOWISH BROWN CLAY (10YR, 5/4) DRY. STIFF VERY DARK GRAYISH BROWN (10YR, 3/2) DRY.	ML CL	3.0 2.0	Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
3.0	07911 01/20/88 1010	2 2 5	8	STIFF VERY DARK GARYISH BROWN (10 YR 3/2) DRY.	CL	2.0	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
4.5	07912 01/20/88 1015	3 5 7	10	VERY STIFF YELLOWISH BROWN CLAY (10 YR 5/4) DRY TRACE GRAVEL.	CL	2.5	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
6.0	07913 01/20/88 1022	4 8 9	10	VERY STIFF DARK BROWN CLAY (10YR, 4/3) DRY, TRACE OF GRAVEL.	CL	3.0	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
7.5	07914 01/20/88 1026	15 19 21	18	HARD DARK BROWN CLAY (10YR 4/3) DRY. TRACE OF GRAVEL.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
9.0	07915 01/20/88 1032	28 29 33	14	HARD DARK GRAYISH BROWN CLAY (10YR 3/2) DRY, TRACE OF GRAVEL.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
10.5	07916 01/24/88 0909	6 14 17	16	HARD DARK GRAYISH BROWN CLAY (10YR 3/2) DRY, TRACE OF GRAVEL.			Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
12.0	07917 01/24/88 0923	15 16 23	18	HARD DARK BROWN CLAY (10YR 4/3) TRACE OF GRAVEL. DRY.	CL	4.0	Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
13.5	07918 01/24/88 0952	8 11 10	12	HARD DARK GRAYISH BROWN CLAY (10YR, 3/2) TRACE OF GRAVEL, DRY.		4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
15.0	07919 01/24/88 0957	10 13 16	8	HARD DARK GRAYISH BROWN CLAY (10YR, 3/2) TRACE OF GRAVEL, DRY.		4.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRIAG COULTER, BACKGROUND MEASUREMENTS, WATER USED - 150 + 80 + 3000, SAMPLES VIA MUNCELL COLORS ASTM, ASTM FOLLOWED FOR SPT

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26 — DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A — DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A — DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL	PAGE 2 OF 10

DEPTH	SAMPLE / DATE / TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
16.5	07920 01/24/88 1045	8 10 11	10	HARD YELLOWISH BROWN CLAY (10YR, 5/6) TRACE GRAVEL, DRY.	CL	4.0	Hnu= 0 α = 0 βΓ = 120
18.0	07921 01/24/88 1440	5 9 13	10	HARD YELLOWISH BROWN CLAY (10YR, 5/6) TRACE GRAVEL, DRY.	CL	4.0	Hnu= 0 α = 0 βΓ = 120
19.5	07922 01/24/88 1505	4 7 11	14	VERY STIFF YELLOWISH BROWN CLAY (10YR 5/6) TRACE GRAVEL, DRY.	CL	3.5	Hnu= 0 α = 0 βΓ = 100
21.0	07923 01/24/88 1542	8 14 17	14	VERY STIFF DARK BROWN CLAY (10YR, 4/3) TRACE GRAVEL, DRY.	CL	3.5	Hnu= 0 α = 0 βΓ = 100
22.5	07924 01/24/88 1630	13 11 18	10	VERY STIFF YELLOWISH BROWN CLAY (10YR, 5/6), DRY. VERY STIFF DARK GREY CLAY (5Y, 4/1), DRY.	CL CL	2.5 2.5	Hnu= 0 α = 0 βΓ = 140
24.0	07925 01/24/88 1645	9 11 17	14	VERY STIFF DARK GRAY CLAY (5Y, 4/1) DRY.	CL	2.5	Hnu= 0 α = 0 βΓ = 180
25.5	07926 01/25/88 0850	8 12 17	14	VERY STIFF DARK BROWN CLAY (10YR, 4/3) WITH LENSES OF DARK GRAY CLAY (5Y 4/1), TRACE GRAVEL, DRY.	CL	3.5	Hnu= 0 α = 0 βΓ = 100
27.0	07927 01/25/88 0920	8 12 16	16	VERY STIFF DARK BROWN CLAY (10YR, 4/3), TRACE GRAVEL, DRY.	CL	2.5	Hnu= 0 α = 0 βΓ = 120
28.5	07928 01/25/88 0940	18 28 25	8	VERY STIFF DARK BROWN CLAY (10YR, 4/3) WITH TRACE OF SAND, MOIST.	CL	3.0	Hnu= 0 α = 0 βΓ = 100
30.0	07929 01/25/88 1045	8 11 23	8	VERY STIFF DARK GREY CLAY (2.5Y, 4/0) TRACE GRAVEL, DRY.	CL	3.5	Hnu= 0 α = 0 βΓ = 100

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS.
WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNSELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

FERNALD RI/FS — VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 3 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
31.5	07930 01/25/88 1345	21 24 50	8	VERY STIFF OLIVE YELLOW CLAY (2.5Y, 6/6), TRACE GRAVEL, DRY.	CL	3.0	Hnu= 0 ppm α = 0 cpm βΓ = 120 cpm
33.0	07931 01/25/88 1428	24 34 38	16	VERY DENSE OLIVE YELLOW SAND (2.5Y, 5/6), DRY.	SW	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
35.0	07932 01/25/88 1450	22 24 18	24	VERY DENSE OLIVE YELLOW SAND (2.5Y, 5/6), DRY.	SP	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
40.0							
41.5	07933 01/26/88 1015	16 16 24	18	DENSE YELLOWISH BROWN SAND (10YR, 5/6), TRACE GRAVEL, DRY.	SP	1.0	Hnu= 0 ppm α = 0 cpm βΓ = 140 cpm
45.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS. WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 4 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
46.5	07934 01/26/88 1340	20 26 28	18	VERY DENSE YELLOWISH BROWN SAND (10YR, 5/6), DRY.	SP	1.0	Hnu= 0 pp α = 0 cp βΓ = 140 cp
50.0							
51.5	07935 01/26/88 1440	5 11 23	16	DENSE YELLOWISH BROWN SAND (10YR, 5/4), DRY. DENSE YELLOWISH BROWN SAND (10YR 5/4), MOIST.	SM	<1 <1	Hnu= 0 pp α = 0 cp βΓ = 100 cp
55.0							
56.5	07936 01/26/88 1600	9 13 23	18	DENSE YELLOWISH BROWN SAND (10YR, 5/4), MOIST.	SM	<1	Hnu= 0 pp α = 0 cp βΓ = 100 cp
60.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS.
WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 5 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
61.5	07937 01/26/88 1653	11 13 23	18	DENSE YELLOWISH BROWN SAND (10YR, 5/4), MOIST.	SM	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
65.0							
66.5	07938 01/27/88 1030	9 21 23	16	DENSE DARK YELLOWISH BROWN (10YR, 4/6) TRACE GRAVEL, WET.	SW	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
70.0							
71.5	07939 01/27/88 1105	7 16 21	18	DENSE DARK YELLOWISH BROWN (10YR, 4/6) TRACE GRAVEL, WET.	SW	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
75.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS. WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

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FERNALD RI/FS — VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 6 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
76.5	07940 01/27/88 1605	22 24 32	18	VERY DENSE DARK YELLOWISH BROWN SAND (10YR, 4/4) VERY COARSE, WET, GRAVEL.	SW	<1	Hnu= 0 pp α = 0 cp βΓ = 100 cp
80.0							
81.5	07941 01/27/88 1655	5 3 5	18	LOOSE DARK YELLOWISH BROWN SAND (10YR, 4/6), POORLY SORTED, TRACE GRAVEL, WET.	SW	<1	Hnu= 0 pp α = 0 cp βΓ = 80 cp
85.0							
86.5	07942 01/28/88 0910	18 29 50	18	VERY DENSE DARK YELLOWISH BROWN SAND (10YR, 4/6), POORLY SORTED, WET.	SW	<1	Hnu= 0 pp α = 0 cp βΓ = 140 cp
90.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIM HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS. WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 7 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
91.5	07943 02/03/88 1440	22 19 24	16	DENSE GRAYISH BROWN GRAVEL (10YR, 5/2) WITH SAND, WET.	GW	<1	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
95.0							
96.5	07944 02/03/88 1515	13 24 37	12	VERY DENSE DARK GREY SAND (10YR, 4/1), VERY FINE.	SM	<1	Hnu= 0 ppm α = 0 cpm βΓ = 100 cpm
100.0							
101.5	08175 02/04/88 1450	40 49 50		BLOW SAND, VERY DENSE DARK GREY SAND (10YR, 4/1).			
105.0							

NOTES:
NO RECOVERY AFTER 2 ATTEMPTS. SAMPLES VIA MUNSELL COLORS ASTM, ASTM FOLLOWED FOR SPT.

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 8 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
106.5	08176 02/08/88 1505	50 50 50	6	VERY DENSE DARK BROWN SAND (10YR, 4/3), WET.			Hnu= 0 pp α = 0 cp βΓ = 80 cp
108.5	08177 02/08/88 1700		2	SHELBY TUBE, BLUE CLAY CONTACT???.			
110.0							
111.5	08178 02/09/88 1015	22 50	4	VERY DENSE, DARK GRAY, WELL-GRADED SAND, GRAVELLY (5Y, 4/1), WET.	SW	N/A	Hnu= 0 pp α = 0 cp βΓ = 160 cp
115.0							
116.5	08179 02/09/88 1425	32 50	9	VERY DENSE, VERY DARK GRAYISH BROWN, POORLY-GRADED SAND, WET (10YR, 3/2).	SP	N/A	Hnu= 0 pp α = 0 cp βΓ = 120 cp
120.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIME HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS. WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM. ASTM FOLLOWED FOR SPT.

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 9 OF 10

DEPTH	SAMPLE / DATE / TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
121.5	08180 02/10/88 1320	50	6	VERY DENSE, VERY DARK GRAY GRAVELLY SAND (10YR, 3/1) NO FINES, POORLY SORTED, WET.	GW	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
125.0							
126.5	08181 02/10/88 1555	50	6	VERY DENSE, VERY DARK GRAY GRAVELLY SAND (10YR, 3/1) NO FINES, POORLY SORTED, WET.	GW	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
130.0							
131.5	08182 02/16/88 0935	6 8 12	8	MEDIUM DENSE, VERY DARK GREY GRAVEL (10YR, 3/1) NO FINES, WET, LARGE FRAGMENTS.	GW	<1	Hnu= 0 ppm α = 0 cpm βγ = 100 cpm
135.0							

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIME HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS. WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM. ASTM FOLLOWED FOR SPT.

FERNALD RI/FS | VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3.2	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 3004	COORDINATES: NORTH 481,427.82 EAST 1,377,896.26	DATE: 01/20/88
GROUND ELEVATION: 579.1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 01/20/88
ENGINEER/GEOLOGIST: M. GOLDBERG	Depth N/A Date/Time N/A	DATE COMPLETED: 02/17/88
DRILLING METHODS: CABLE-TOOL		PAGE 10 OF 10

DEPTH	SAMPLE DATE TIME	BLOWS ON SAMPLE	RECOVERY INCHES		USCS SYMBOL	TSF	REMARKS
136.5	08183 02/16/88 1110	22 16 12		DENSE DARK GRAY GRAVEL (10YR, 3/1), TRACE CLAY, WET, POORLY SORTED.			Hnu= 0 pp α = 0 cp βΓ = 100 cp

BOTTOM OF BORING 135

NOTES:
DRILLING CONTRACTOR: PENNSYLVANIA DRILLING, DRILLER: TIME HARRIS, HELPER: CRAIG COULTER. BACKGROUND MEASUREMENTS.
WATER USED - 150 + 80 + 3000. SAMPLES VIA MUNCELL COLORS ASTM. ASTM FOLLOWED FOR SPT.

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ATTACHMENT C

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Attachment C

HEALTH AND SAFETY PLAN

FOR THE

DIKE STABILITY INVESTIGATION

OF WASTE PITS 3 AND 5

AND THE CLEARWELL

AT THE

FEED MATERIALS PRODUCTION CENTER

FERNALD, OHIO

MAY 1991

Prepared By:

PARSONS
Fairfield Executive Center
6120 South Gilmore
Fairfield, OH 45014

DOE Contract No. DE-AC05-900R21951

HEALTH AND SAFETY PLAN
FOR THE
DIKE STABILITY INVESTIGATION
OF WASTE PITS 3 AND 5
AND THE CLEARWELL

PARSONS

Prepared by: ______________________ 5-17-91
Health and Safety Coordinator — Date

Approved by: ______________________ 5-17-91
Operable Unit 1 Manager — Date

WESTINGHOUSE MATERIALS CO. OF OHIO

Reviewed by: ______________________ 5/17/91
Project Engineer — Date

Recommended for Approval by: ______________________ 5-17-91
Operable Unit 1 Manager — Date

Approved by: ______________________ 5/23/91
for Vice President - Industrial, Radiological, Safety and Training — Date

U.S. DEPARTMENT OF ENERGY

Approved by: ______________________ 5/17/91
Operable Unit 1 Manager — Date

Approved by: Ray Hansen for ______________________ 5/23/91
Project Manager — Date

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HEALTH AND SAFETY PLAN
FOR THE
DIKE STABILITY INVESTIGATION
OF WASTE PITS 3 AND 5
AND THE CLEARWELL

CONTENTS

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CONTENTS (Continued)

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CONTENTS (Continued)

FIGURES

ATTACHMENTS

SECTION 1

TASKS TO BE PERFORMED[1]

This task-specific Health and Safety Plan was prepared as a supplement to the formal Health and Safety program at the FMPC. This Health and Safety Plan will be used by WMCO in conducting field activities as described herein. The tasks covered by this Health and Safety Plan consist of soil boring, collection of subsurface soil samples, drilling and construction of piezometric wells, and abandonment of bore holes and piezometric wells in the dikes surrounding Waste Pits 3 and 5 and the Clearwell at the FMPC. The purpose of these tasks is to evaluate the structural integrity of the waste pit dikes and to determine the potential threat of dike failure and the resulting release of waste pit and Clearwell contents to Paddy's Run.

Prior to the drilling and sampling activities in these areas, a series of survey target and control monuments will be installed to allow periodic monitoring of the dikes. The management and preparation of a Health and Safety Plan for the installation of these monuments is being conducted by WMCO.

Approximately sixteen (16) soil borings will be made in the dikes surrounding Waste Pits 3 and 5 and the Clearwell. Borings will be made at the toe as well as at the top of the dike along the perimeter of each waste pit. Drilling technicians will use split-barrel and, at selected sampling locations, thin-walled (shelby) tubes to collect subsurface soil samples during the construction of the borings. Soil borings are not expected to exceed a depth of approximately 35 feet. Following sample collection, a variety of laboratory tests, i.e., moisture contents, permeability, triaxial shear, etc., will be performed on the soils.

Piezometric wells will be installed along the dikes based on conditions encountered in the field. Well casing and screen material will be installed in each well. The static water level in each piezometric well will be monitored by WMCO personnel on a periodic schedule.

The drilling subcontractor will abandon the soil boring holes without piezometric wells by grouting the holes subsequent to the completion of the dike stability evaluation. WMCO will abandon the soil boring holes with piezometric wells.

Listed in Subsections 1.1 through 1.5 are several of the major dike stability investigation activities and a checklist of standard actions that may or may not occur for each activity.

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[1]The plan is consistent with 29 CFR 1910.120 and the FMPC Site Health and Safety Plan.

1.1 Effects of Conducting Soil Borings on the Dikes Surrounding Waste Pits 3 and 5 and the Clearwell

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.2 Effects of Collecting Subsurface Soil Samples

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.3 Effects of Drilling and Constructing Piezometric Wells

Yes	Disturb Surface Soil	No	Sample Surface Water
Yes	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.4 Effects of Monitoring the Piezometric Wells

No	Disturb Surface Soil	No	Sample Surface Water
No	Disturb Subsurface Soil	No	Sample Lagoons
No	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

1.5 Effects of Abandoning Bore Holes and Piezometric Wells

Yes	Disturb Surface Soil	No	Sample Surface Water
No	Disturb Subsurface Soil	No	Sample Lagoons
Yes	Use Heavy Equipment	No	Use Boat
No	Enter Confined Space	Yes	Involve Radioactivity
No	Disturb Containerized Matter	No	Involve Trenches

SECTION 2

SITE HISTORY

Since the beginning of uranium production operations at FMPC in 1952, an on-site area has been used for the storage of low-level radioactive wastes generated by the various chemical and metallurgical processes at the facility. The waste storage area, which consists of six waste pits, the Clearwell, and the burn pit, is located in the northwestern corner of the FMPC Site (Figure 2-1). The tasks addressed by this Health and Safety Plan are specifically related to Waste Pit 3, Waste Pit 5, and the Clearwell.

Waste Pit 3 was constructed in 1959 and was excavated to a depth of 27 feet. A minimum of 12 inches of compacted clay was used to line the inner slopes of the walls. In 1965, the pit capacity was expanded by adding 2 feet of additional material to the top of the pit walls. The pit consisted of a large settling basin with a concrete spillway overflowing into the clay-lined Clearwell. This was the first "wet" pit built for the purpose of settling solids from wet waste streams. The pit was operated as a settling basin from 1959 to 1968; it received wet waste streams consisting of lime-neutralized radioactive raffinate concentrate from the Recovery Plant and the general sump. The principal waste contained in Pit 3 is lime-neutralized, radioactive raffinate concentrate. Beginning in December 1958, lime sludge from the Water Treatment Plant was added to supplement the lime used for raffinate neutralization. During the late 1960s, large quantities of radioactive slag leach residues were pumped to Pit 3. After October 1968, Pit 5 was used as the settling basin. From 1975 to 1977, solid wastes (filter cake and fly ash) were used to complete the filling of the pit. Waste Pit 3 contains an estimated 227,000 cu yd of wastes, including 129,000 kg of uranium and 400 kg of thorium. The pit was closed in 1977, and clean fill was placed over the waste.

Waste Pit 5 was constructed in 1968 and operated from 1968 to 1983. The pit was lined with a 60-mil-thick elastometric membrane. As with Waste Pit 3, this waste pit received liquid waste slurries from the Refinery and the Recovery Plant, including neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge. The waste volume consists of approximately 102,500 cu yd, which contains 50,309 kg of uranium and 17,000 kg of thorium. From 1983 to February 1987, when it was taken out of service, Pit 5 received only clear decant from the general sump, filtrate from the recovery plant, or nonradioactive slurries, such as blowdown from the Boiler Plant and Water Treatment Plant. The surface of Waste Pit 5 is open and has not been covered with any type of fill material.

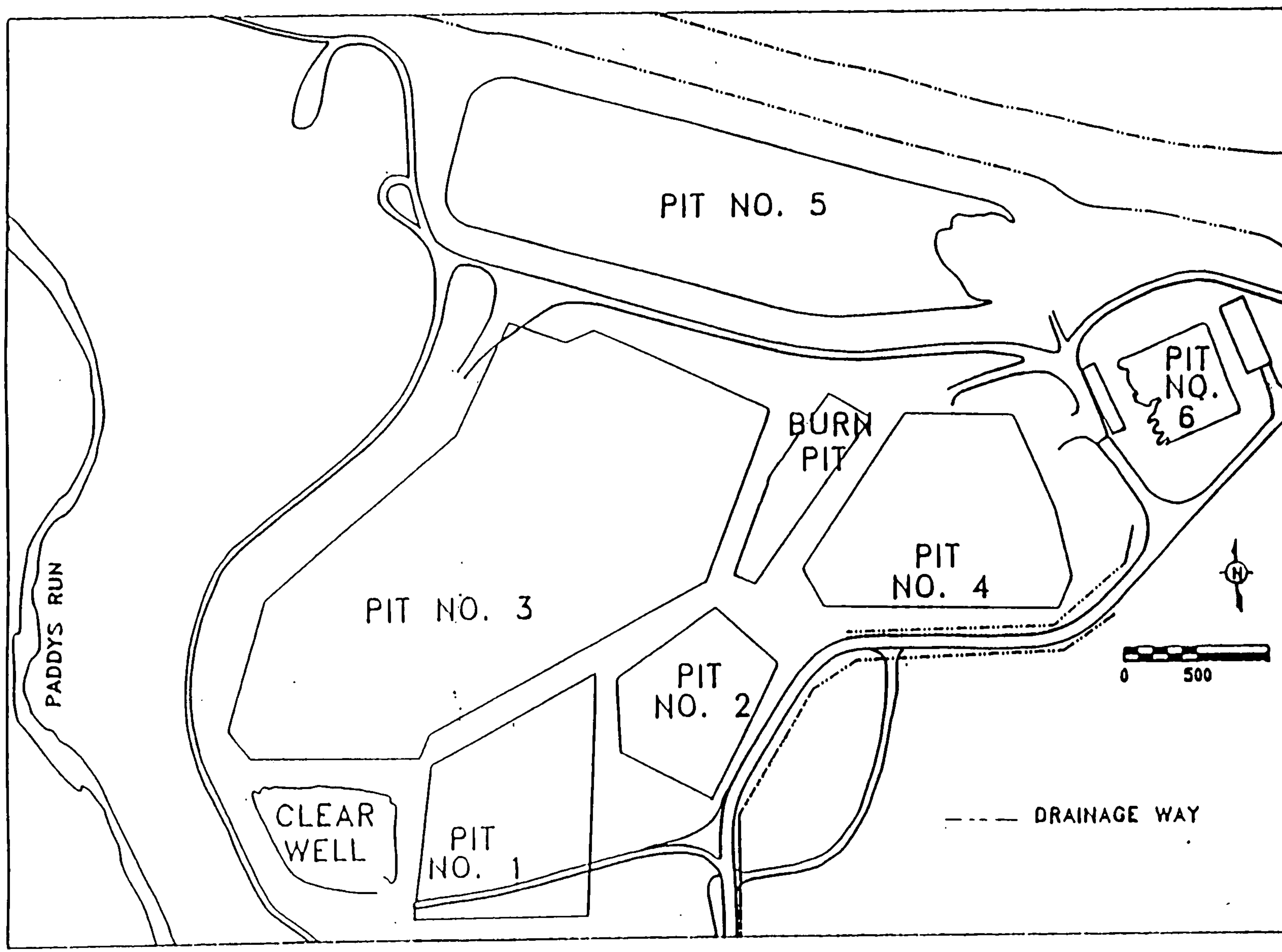

Figure 2-1 - FMPC Waste Storage Areas

The Clearwell served as a settling basin for process water and storm water runoff from the waste pits. The Clearwell was used as a final settling basin for process water that passed through Waste Pit 5 prior to its discharge into the Great Miami River. This use was terminated in March 1987 when Waste Pit 5 was removed from the process water treatment system. The Clearwell currently receives surface water runoff from the majority of the surfaces of Waste Pits 1, 2, and 3, and from the entire surface of Waste Pit 5. Water of varying depth remains in the Clearwell at all times. The depth of sediments in the Clearwell is unknown.

SECTION 3

TASK SPECIFIC HAZARD ASSESSMENTS

3.1 Hazard Assessment

An evaluation of the tasks to be conducted during the dike stability investigation indicates that physical, radiological, and chemical hazards will be present. Table 3-1 lists the anticipated hazards associated with each of the five major work tasks identified in Section 1.

Table 3-1
Hazards Associated With Dike Stability
Investigation For Waste Pits 3 and Clearwell

TASK	PHYSICAL HAZARDS	CHEMICAL HAZARDS	RADIOLOGICAL HAZARDS
Soil Borings on Waste Pit and Clearwell Dikes	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Collection of Samples	Slip, trip, fall, vehicle traffic, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Installation of Piezometric Wells	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Monitoring the Piezometric Wells	Slip, trip, fall, heat/cold stress, drowning	Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates
Abandonment of Boreholes and Wells	Noise, vehicle traffic, slip, trip, fall, moving drilling equipment, heat/cold stress, drowning	Portland cement, Bentonite, Vehicle Emissions, Note 1	Low levels of penetrating gamma radiation. Potential inhalation or ingestion of radioactive particulates

NOTES:

1: Previous sampling of Waste Pits 3 and 5 contents indicated the presence of several organic and inorganic contaminants, i.e., barium, acetone, methylene chloride. These chemicals may have migrated into the dikes surrounding the waste pits; however, no sampling data exists to support this possibility.

3.2 Chemical and Radiological Hazards

Table 3-2 lists the primary hazard, exposure limit, and action level for the chemicals and radionuclides that will likely be encountered during the dike stability investigation. Based on surface and subsurface soil sampling conducted during the Remedial Investigation (1990), several radionuclides (radium, thorium, and uranium) were identified at levels above background in the soil on the perimeter of the waste pits and the Clearwell. During the Remedial Investigation, ten (10) surface soil samples were collected from the perimeter of these areas. Radium-226, -228, thorium-228, -230, -232, uranium-234, and -238 were consistently detected in the soil samples. The concentration ranges for these radionuclides in pCi/g were: <0.3 to 1.2 for radium-226, <0.5 to 1.8 for radium-228, <0.6 to 13.6 for thorium-228, 0.8 to 6.1 for thorium-230, <0.6 to 1.4 for thorium-232, <0.6 to 5.3 for uranium-234, and <0.6 to 16.1 for uranium-238. Also during the Remedial Investigation, a total of twenty-six (26) subsurface soil samples were collected from various depths of twenty wells that had been drilled in the waste pits area. The same seven radionuclides that had been consistently detected in the surface soil samples were also consistently detected in the subsurface soil samples. Of the subsurface soil samples collected adjacent to the dikes of Waste Pits 3 and 5 and the Clearwell, the highest concentration for any of the seven consistently detected radionuclides was 89.4 pCi/g for uranium-238. All other radiounuclides were generally observed in concentrations less than 10 pCi/g.

Previous radiation measurements (Radiological and Chemical Characterization of the Waste Pits, CIS, Volume 2, Weston, 1987)) indicated that radioactive material is widely distributed as well as located in isolated small deposits in the waste pit area. During the 1987 Weston study of the waste pits at FMPC, a variety of organic and inorganic chemical constituents were identified in the contents of Waste Pits 3 and 5 and the Clearwell. Volatile and semi-volatile organic chemicals in the contents of these three pits were observed at concentrations of 4.5 ppm or less. Inorganic chemicals in the pit contents were generally observed at concentrations comparable to soils found throughout the eastern United States. Because the drilling activity will occur in the dikes surrounding the waste pits and the Clearwell, it is unlikely that drilling personnel will encounter the chemicals from the waste pit contents. The chemicals of concern are bentonite and Portland cement. These items, which pose a respiratory hazard because of their powder nature, will be used as a grout mixture to seal the boring and piezometer well holes.

Table 3-2
Chemical And Radiological Hazard Table

POTENTIAL CONTAMINANT	PRIMARY HAZARD	EXPOSURE[1] LIMIT	ACTION LIMIT	ACTION
Radium-226	Ingestion/Inhalation	3×10^{-10} µCi/ml[2]	-	-
Radium-228	Ingestion/Inhalation	5×10^{-10} µCi/ml[2]	-	-
Thorium-228	Ingestion/Inhalation	4×10^{-12} µCi/ml[2]	-	-
Thorium-230	Ingestion/Inhalation	3×10^{-12} µCi/ml[2]	-	-
Thorium-232	Ingestion/Inhalation	5×10^{-13} µCi/ml[2]	-	-
Uranium-234	Ingestion/Inhalation	2×10^{-11} µCi/ml[2]	-	-
Uranium-238	Ingestion/Inhalation	2×10^{-11} µCi/ml[2]	-	-
Bentonite (Crystalline silica as respirable dust, quartz standard)	Ingestion/Inhalation	0.1 mg/m^3	0.05 mg/m^3	[3]
Portland Cement (Respiratory standard)	Ingestion/Inhalation	5.0 mg/m^3	2.5 mg/m^3	[3]

NOTES:

[1] The Exposure Limit values are given for individual radionuclides. For known mixtures of radionuclides, the sum of the ratio of the observed concentration of a particular radionuclide and its corresponding limit for all radionuclides in the mixture must not exceed 1.0.

[2] This is the Derived Air Concentration (DAC).

[3] Full-face air purifying respirators with high efficiency/radionuclide filter cartridges.

SOURCES:

DOE Order 5480.11, "Radiation Protection For Occupational Workers," U.S. Department of Energy, July 20, 1989.

NIOSH Pocket Guide to Chemical Hazards, U.S. Department of Health and Human Services, June 1990 (Bentonite and Portland Cement).

3.3 Physical Hazards

The terrain surrounding Waste Pits 3 and 5 and the Clearwell varies from steep to level. The outer sides of the earthen dike surrounding Waste Pit 5 slope at an angle of 34° (1-foot rise to 1.5-foot run) and range in height from 10-25 feet. The width of the top of the dike ranges from 8-15 feet. Waste Pit 5 remains an open pit. The pit liner is visible along the entire perimeter of Waste Pit 5. With the exception of the eastern end of the pit, water covers the entire surface of Waste Pit 5; the eastern end of the pit is covered with sediments and sludges.

The dike surrounding Waste Pit 3 is only visible on the western side of the waste pit; the outer dike surface is approximately 15-20 feet high and slopes at an angle similar to the dike surrounding Waste Pit 5. Waste Pit 3 has been covered with clean fill material and was graded to a slightly crowned surface. The entire Waste Pit 3 surface is now grass-covered. The Clearwell is also an open pit whose surface is covered with water. The dike surrounding the Clearwell is only visible along the western and southern sides of the pit.

Due to the variable terrain and proximity to open and liquid and sludge-filled pits, a variety of physical hazards are present during the dike stability investigation field work. Slipping, tripping, and falling by field workers and the movement and use of drilling rigs and related equipment along the pit and dike edges represent the most immediate physical hazards. Of particular note are physical hazards associated with the operation of the drilling rigs: falling or breaking machinery parts, rotating parts, cables under tension, and obstructed views by the operator. In addition, workers may be exposed to high levels of noise and to heat/cold stress during drilling and sampling activities. The potential for drowning exists for those personnel who may accidentally fall into Waste Pit 5 or the Clearwell during work activities.

SECTION 4

MONITORING

4.1 Goals

Prior to any task being performed on the waste pit and Clearwell dikes, air monitoring will be conducted by WMCO Radiological Safety and Environmental Monitoring personnel, as required at the time of work permit(s) issuance, to ensure that exposure limits are not exceeded. Radioactive contamination monitoring will be performed when soil media is disturbed in order to ensure that the spread of contamination is minimized.

4.2 Monitoring Equipment And Frequency of Monitoring

4.2.1 Airborne Radioactive Particulates

A representative air sample in the immediate breathing zone or general area of a worker actively involved in drilling operations will be collected to determine the concentration of long-lived airborne radioactive particulates to which workers are exposed. The sample will be collected using portable, battery-powered air pumps with 37 mm diameter membrane filters. The air sample filter will be checked for gross radioactivity to verify the adequacy of respiratory protection. A daily air sample which indicates that personnel may have been exposed to greater than 40 Derived Air Concentration (DAC)-hours in one week without respiratory protection will trigger dose assessment by WMCO Radiological Safety, Dosimetry Subsection.

4.2.2 Radioactive Surface Contamination

When personnel are working on the waste pit dikes, daily surveys of removable radioactive surface contamination will be performed by WMCO Radiological Safety personnel in the work area. Direct reading instruments and/or field swipe surveys will be used on drilling and sampling equipment. Alpha, beta, and gamma detectors will be used by a WMCO Radiation Technician to monitor each soil boring sample collected during the drilling operation.

4.2.3 Radiation Surveys

Prior radiation surveys will be used by WMCO Radiological Safety to establish general area radiation levels. Radiation surveys will be conducted by WMCO Radiological Safety personnel periodically during field activities. Portable radiation monitoring devices will be calibrated and maintained in accordance with WMCO Standard Operating Procedure SP-P-35-028, "Inspection and Performance Testing of Portable Radiation Survey Instruments."

4.2.4 Chemical Hazards

Exposure to significant chemical vapor concentrations are not expected during the dike stability investigation tasks. However, a photoionization detector (HNu) will be used by WMCO Environmental Monitoring personnel to monitor the air near the breathing zone of the drilling technicians during actual drilling operations. The HNu will also be used to monitor each soil boring sample for evidence of organic chemical contaminants.

4.2.5 Thermoluminescent Dosimetry

Thermoluminescent dosimeters (TLDs) will be worn by all field personnel during all aspects of dike stability investigation field activities.

4.2.6 Physical Hazards

Based on the range of average daily maximum air temperatures expected during field activities (76-84 degrees F), heat stress monitoring of personnel may be required. When the temperature is 85 degrees F or above, attention must be given to the possibility of heat stress. Heat stress monitoring of personnel will be directed by the RUST Project Engineer. Attachment A provides guidance for heat stress monitoring and prevention. Personnel should be aware that "cool vests" are available if needed. The RUST Project Engineer will check with WMCO Security each day prior to drilling activities in order to receive a weather forecast. If severe weather is forecast, frequent contact will be made with WMCO Security for updated weather reports.

All drill rig personnel will be required to wear hearing protection while the drill rig is in operation.

Each drill rig will be inspected by the drilling operator on a daily basis. Broken or worn parts will be replaced and safety features or interlocks will be tested to ensure that they are functional.

Underground and overhead utilities, i.e., electricity, natural gas, storm sewers, and telephone lines, will be identified and marked by WMCO utility engineers prior to any drilling activity.

All personnel who work within five feet of the edge of a waste pit which contains liquid are required to wear a personal flotation device.

4.3 Field Action Limit Guidelines

Table 4-1 presents the field action limit guidelines for radiological and chemical contaminants that may be encountered in the work environment during field activities.

Table 4-1
Field Action Limit Guidelines

INSTRUMENT	INTERVAL	LIMIT	ACTION
Alpha Probe[2/]	Pre-Job and Intermittent[1/]	500 cpm[3/] >25,000 cpm	APR[4/] Withdraw
Beta/Gamma Probe[2/]	Pre-Job and Intermittent[1/]	5,000 cpm[3/] >250,000 cpm	APR[4/] Withdraw
Hnu Meter	Intermittent[1/]	Detection to 10 ppm[5/] 10-25 ppm >25 ppm	APR[4/] SAR[6/] Withdraw

1/ "Intermittent is as deemed necessary by the WMCO Radiological Safety and/or Environmental Monitoring, or at a minimum of once a day.

2/ "Frisking" for alpha contamination and beta/gamma contamination using hand held alpha scintillator and Geiger Mueller detectors respectively.

3/ Above background.

4/ Full-face purifying respirators with HEPA or organic vapor, acid gas, fume cartridges (H.P. Review). Disposable protective clothing, such as Saranax coveralls and a step-off decontamination will also be required at any time APR are used.

5/ 1 ppm above background.

6/ Supplied Air Respirator.

Radiation levels in the work environment are expected to be less than 0.5 penetrating mrem/hr. These levels will be used to evaluate stay times on the Radiation Work Permit.

SECTION 5

PERSONAL PROTECTIVE EQUIPMENT

The specific personal protective equipment (PPE) required for each task will be determined at the time the FMPC Work Permit(s) is/are issued. The following type of personal protective gear is or may be required during each field activity of the dike stability investigation.

ITEM	NEED	JUSTIFICATION
Hard Hat	Yes	Head injury protection
Hearing Protection	Yes/No	As specified by IRS&T based on the noise level of drilling operations
Safety Glasses	Yes	Minimum requirement, but may be satisfied by full-face respirator
Safety Goggles/ Face Shield	Yes	Eye splash protection where full-face respirator is not used
Steel-Toed Shoes	Yes	Minimum requirement
Shoe Covers	Yes	Minimum requirement
Rubber/Latex Boots	Yes/No[1]	Additional protection against liquid contact
Inner Gloves	Yes/No[1]	Used beneath leather-palm gloves
Leather-Palm Gloves	Yes/No[1]	Physical protection of hands during drilling and sample handling
Rubber/Nitrite Gloves	Yes/No[1]	Additional protection against liquid contact
Controlled Area Coveralls	Yes	Minimum requirement for work in exclusion area
Cloth Hood	Yes/No	Additional splash protection
Full-face air purifying respirator	Yes/No	Respiratory protection
Dust filters	Yes	Respiratory protection when working with bentonite and Portland cement
Safety Belt and Line	Yes/No	Required by workers who may be working 4 feet or higher above the drill rig bed
Supplied Air Respirator	Yes/No	Respiratory protection
Personal Flotation Device	Yes/No	Required by workers conducting activities within 5 feet of waste pit edge

[1] Equipment item will be required if the WMCO Radiological Safety Technician determines that its use is necessary.

SECTION 6

WORK SITE SAFETY REQUIREMENTS

6.1 Equipment Safety

Drill rigs used for the dike stability investigation must be of a size adequate to accomplish the required project work without placing undue strain on the rig or mast and without endangering any person at the drill sites. All rotating shafts, pulleys, or chains must be covered with protective guards. Only rotating cathead drums will not be covered with a guard. Drill rigs must be maintained in good mechanical operating condition. All drill rigs must be equipped with an emergency kill switch readily accessible to crew personnel at the rear of the drill rig. Only authorized and qualified personnel will be allowed to operate the drill rig.

If a steam cleaner or power sprayer is used to clean/decontaminate drilling equipment, the cleaning must be conducted in a manner that directs the flow of high-pressure water or steam away from persons not involved in the cleaning. Hearing protection may be required if the cleaning device exceeds the OSHA noise standard of 90 decibels during operations. The use of a steam cleaner or power sprayer will likely be conducted at the FMPC Site Decontamination Facility.

All utility vehicles and trailers must be maintained in good condition for hauling loads to and from the drill sites. When parked at the drill site, all utility vehicles must be secured by wheel chocks or any other device to prevent accidental rolling or movement. Acceptable wheel chocks are those constructed of reinforced rubber or wood. Pickup trucks and other vehicles used primarily for personnel transportation do not require wheel chocks.

6.2 Drilling Area Safety

As soon as the drill rig is driven into position for drilling, a rope barricade must be erected around the entire drilling area. The barricade must extend outward from the rig far enough to contain any equipment that might fall from the rig. Signs which indicate the required safety equipment must be attached or posted on the barricade. The rope barricade must be maintained in position as long as the drill rig is on site.

6.3 Drill Rig Operations Safety

All required equipment and materials should be placed around the work site in a neat and orderly manner. Particular attention should be given at this time to potential safety hazards from objects which could fall from the bed of the drill rig or roll off a utility trailer. Drilling operations should not begin until all equipment is in place and the crew is ready to devote full attention to the required work. A minimum of two (2) persons must be present at the drill rig at all times of operation.

Drill rods and drill bit stabilizers must be transported to a work site either in a rack designed to hold such equipment on the drill rig or water truck, or on a utility trailer. If transported on a utility trailer, the drill rods and/or bit stabilizers must be held securely in place so that they will not roll form side to side. In addition, metal stakes must be in place on the sides of the trailer to prevent any loose rods from falling off.

At a work site, drill rods and drill bit stabilizers should be set out so that they can be picked up and laid down in a safe manner. They may be laid on crossties on the ground, on steel support racks, or left on the utility trailer. However, regardless of where they are placed, they must be secure from rolling and/or falling. Any support racks used to hold drill rods or stabilizers must have adequate strength to hold this equipment without collapsing. Drill rods and drill bit stabilizers placed directly on the ground must be chocked to prevent rolling.

All wire cabled on a drill rig are to be inspected by the rig operator before the start of work each day. Rig cables must be free of broken strands or weak spots. All wire cable that has broken strands must be replaced immediately. Under no circumstances should a drill rig operator exceed the rated cable load strength. Operators should also avoid putting excessive strain on the mast of the drill rig. In the event a drill rod string becomes stuck in the hole, the operator must attempt to work the equipment loose without endangering anyone by breaking a wire cable.

Certain minimum clearances apply to high-voltage power lines. Should the rig mast come within the minimum clearance as given below, the line must be de-energized, grounded, and locked out, or the work will not be done.

Line Voltage	Minimum Clearance
50 kV or less	10 feet
50 kV to 345 kV	20 feet
345 kV to 750 kV	34 feet

When setting up a drill rig on a hole location close to an overhead power line, the rig should be parked parallel to the line. This will avoid any possibility of the rig rolling into the line. Wheel chocks must be placed under the rig at all times when parked in the vicinity of an overhead power line. When working near power lines, care should be exercised to avoid breaking wire cables, which could then make contact with the line. The drill rig operator should avoid excessive strain on any cable while working in such a location. Any wire cable that is in marginal condition should be replaced before beginning work near a power line. In addition, drill rods are not to be leaned against the mast of the rig while working near an overhead power line.

Due to the construction of a drill rig, with the metal mast up in the air and the drill rods grounded in a hole full of mud and water, the mast can act as a very efficient lightning rod. For this reason, whenever a thunderstorm with visible lightning approaches a drilling work site, all work shall stop. The crew, including the operator, must move away from the drill rig and take cover in other vehicles or shelter. No one shall remain on or anywhere near the drill rig while a thunderstorm with lightning is in the area. The crew may return to the rig and resume work only when the thunderstorm has moved away from the area.

6.4 Sample Handling and Transportation Safety

Soil samples collected during the dike stability investigation will be preserved, packaged, and transported according to the specifications listed in ASTM-D 4220-83, "Standard Practices for Preserving and Transporting Soil Samples." Samples will be screened with direct reading radiation and chemical detection instruments before being taken from the drilling area. Containers into which soil samples are placed, will be surveyed and cleaned to ensure that no radiological contamination is transported off-site. If soil samples are transported off-site for analysis, DOE/FMPC and Department of Transportation (DOT) packaging, labelling, and transportation requirements will be met.

6.5 Borehole Abandonment Safety

During abandonment of the boreholes, bentonite and Portland cement will be combined to produce a grout mixture. Dust filters must be worn by personnel who open and mix these two products.

SECTION 7

SITE CONTROL

7.1 Access

The activities associated with the dike stability investigation will occur entirely within a Controlled Area of the FMPC. The Controlled Areas of the FMPC are controlled in accordance with the Radiological Controls Manual (FMPC-2084) which provides requirements for the following:

1) The wearing of dosimetry
2) Radiation safety training
3) Limitations on entry for personnel with open wounds or recent medical tests with radionuclides
4) Radiological area postings
5) Protective clothing
6) Limitations on food, beverages, and tobacco
7) General rules for work
8) Contamination control
9) Monitoring and showering requirements upon exiting from the Controlled Area and Radiological Areas.

A Radiation Work Permit with the specifications of this task-specific health and safety plan will be required for work in the area.

Per the requirements of 29 CFR Part 1910.120, an exclusion zone (defined by a barricade rope) will be established around the immediate drilling/soil sampling area. The exclusion zone is an area of high potential hazard due to physical, chemical, and/or radiological dangers. Access to the exclusion zone will be restricted to trained and certified personnel who are required to enter to perform their job duties. Due to the nature of the drilling activity, the exclusion zone location and boundaries may vary for each drilling site. Radiological Safety will establish controls consisting of step-off pads at the Controlled Area exit point. This area will be used for monitoring at the step-off pad, removal of disposable personal protective equipment. Only limited equipment decontamination will be allowed at the work site.

7.1.1 Radiological Postings

Radiological areas will be posted in accordance with FMPC Radiation Control Manual (FMPC-2084). Table 7-1 provides a brief summary of posting requirements applicable to radionuclides likely to be encountered during drilling and sampling activities. Radium-226 and thorium 230 are the radionuclides of concern, unless otherwise determined by WMCO Radiological Safety.

7.2 Bioassay Samples

Site personnel involved in this project are required to participate in a routine periodic urine assay program. Any suspected exposure to hazardous substances shall be reported and require additional sampling. If air sample analyses indicate that thorium levels in air were sufficient to deliver more than eight DAC-hours to an individual, in-vivo monitoring and/or other bioassay measurements will be performed on that individual as deemed appropriate by the WMCO Dosimetry Subsection. Air samples, which indicate that personnel may have been exposed to greater than 40 DAC-hours in one week, will trigger dose assessment by WMCO Dosimetry Subsection.

Table 7-1
Posting Requirements

Regulated Area	Contamination Level
(Ra-226, Ra-228, Th-228, and Th-230)	> 20 dpm/100 cm^2 removable > 300 dpm/100 cm^2 fixed and removable
(Beta-gamma emitters)	> 1,000 dpm/100 cm^2 removable > 5,000 dpm/100 cm^2 fixed and removable
Contaminated Area	
(Ra-226, Ra-228, Th-228, and Th-230)	> 200 dpm/100 cm^2 removable > 3,000 dpm/100 cm^2 fixed and removable
(Beta-gamma emitters)	> 10,000 dpm/100 cm^2 removable > 50,000 dpm/100 cm^2 fixed and removable
Airborne Radioactivity Area	Potential for 0.8 DAC hours per shift or > 50,000 dpm/100 cm^2 alpha surface contamination
Respirator Area	> 8.0 DAC hours in a single shift or > 2 DAC hours per shift averaged over one calendar quarter
Radiation Area	> 2.5 mrem/hr and < 100 mrem/hr
SOURCE: FMPC Radiation Control Manual (FMPC-2084), December 31, 1990.	

7.3 Medical Monitoring

In accordance with 29 CFR 1910.120 requirements, all personnel are required to participate in a medical monitoring program which consists of the following items:

1) A baseline medical examination
2) Annual medical examination
3) Medical examinations may be required after potential exposures
4) WMCO respirator clearance for users.

Each individual shall be subject to a medical surveillance approval by the WMCO Director, Medical Services. The approval statement shall certify that each individual is medically qualified to perform the work and is physically fit to wear PPE.

7.4 Training Requirements

All personnel assigned to the tasks will, as a minimum, meet the following training requirements:

1) Documented review of the health and safety plan for this work including site specified hazards and procedures.
2) WMCO radiation safety training
3) WMCO annual respiratory training and quantitative fit test or equivalent approved by WMCO Industrial Hygiene
4) Site nuclear criticality training
5) 40-hour OSHA training
6) 8-hour annual refresher training, as necessary
7) 8-hour supervisory training (for supervisors)
8) 24-hour supervised field experience (general site workers) or 8-hour supervised field experience (occasional site workers)
9) FMPC site orientation video.

The completion of this training shall be documented by the site training personnel.

7.5 Safety Meetings

A safety meeting, which must be documented, shall be conducted prior to the start of each day's work. These safety meetings will cover the following applicable subjects:

1) Work operations
2) Personal protective equipment
3) All monitoring data
4) Hazard communications
5) Monitoring tests and results
6) Decontamination
7) Task organization
8) Physical stress
9) Emergency procedures
10) Communications
11) General safety
12) Housekeeping.

SECTION 8

EXPOSURE SYMPTOMS

Exposure to low levels of radiation does not produce acute exposure symptoms. Such exposures may cause delayed effects such as cancer. Since any radiation exposure may involve some degree of risk, exposures are to be kept as low as reasonably achievable (ALARA). Personnel radiation exposures will be monitored by thermoluminescent dosimeters.

SECTION 9

SITE ENTRY PROCEDURES

Prior to the initiation of the overall project and/or the beginning of daily work activities, the RUST Project Engineer will ensure that the following procedures have been conducted:

1) Procure the necessary work permits (radiation, excavation and penetration, and chemical/hazardous material) for drill rig operations.
2) Conduct safety inspection of all heavy equipment.
3) Establish radio contact, location, and start and stop times with FMPC Control Center.
4) Conduct pre-work plan and safety meeting prior to each day's work activities; exclusion zone, contamination reduction zone, and break areas will be identified.
5) Discuss alternate communication signals (if applicable).
6) Perform respirator check-out and inspection prior to use.
7) Inspect and calibrate all devices to be used for monitoring volatile organic compounds.
8) Assign all personnel who will be working in the exclusion zone (per 29 CFR 1910.120 requirements) to a buddy system.
9) Test and maintain clean liquid in eyewash station.
10) Verify location and operation of all emergency equipment. A list of emergency equipment is shown in Section 12.5.

Entrance to the exclusion zone will be controlled by the RUST Project Engineer (or designee).

SECTION 10

DECONTAMINATION

An exclusion zone will be established around each drilling location in order to control the potential spread of contamination from work activities. As stated in Section 7.1, a contamination reduction zone will be established for removal of disposable personal protective clothing and limited cleaning of contaminated equipment. Personnel will enter and exit the posted work area through a step-off pad. Upon exit, personnel will remove any disposable protective clothing and monitor themselves and any outgoing equipment for contamination. Additionally, decontamination of drilling equipment may be required between borings, or while advancing a boring, to minimize the potential for spread of contamination. All personnel and outgoing equipment will be monitored for contamination in accordance with WMCO Radiation Safety procedures. Action limits on equipment of 20 dpm/100 cm^2 alpha fixed plus removable, 1,000 dpm/100 cm^2 beta/gamma removable, and 5,000 dpm/100 cm^2 beta/gamma fixed plus removable will initiate decontamination activities. Any detectable alpha contamination and greater than 100 cpm beta-gamma contamination on any personnel will be reported to WMCO Radiological Safety, who will assist in decontamination in accordance with WMCO Radiation Safety procedures. The majority of equipment associated with drilling operations will be decontaminated at the FMPC Site Decontamination Facility. Only sampling equipment, i.e., pans, trowels, and other limited drilling equipment, as specified by WMCO, will be decontaminated at the work site. If the equipment cannot be decontaminated to acceptable levels, it will be disposed as radioactive waste.

SECTION 11

WASTES

Waste that is expected to be generated during work activities includes soil borings and cuttings, drilling fluids, disposable personal protective clothing, decontamination solution and material, and contaminated well casings. Potentially contaminated waste material will be collected, segregated, and placed in drums or other containers. Disposable protective clothing will be placed in plastic bags and disposed as compactible, potentially contaminated waste. Liquid waste collected from drilling and decontamination efforts will be transferred to the appropriate FMPC storage location.

Waste drums or containers shall meet the requirements of 49 CFR Parts 171-178, 40 CFR Parts 265-265 and 300, and OSHA. Hazard warning labels will immediately be applied to all drums as specified by WMCO Transportation and Solid Waste Compliance.

SECTION 12

CONTINGENCY PLANS

The plans shall be consistent with FMPC-2046, "FMPC Emergency Plan."

12.1 Incidents or Injuries Involving Possible Intake of Radiological or Chemical Substances by Employees

Incidents or injuries involving potential intake of uranium or other hazardous substances shall be reported to the RUST Project Engineer and the WMCO Medical Section by the involved employee, and an Incident Investigation Report shall be completed by the involved employee. Incident urine samples shall be submitted at the end of the shift and at the start of the next shift if exposure involves uranium.

12.2 Pre-Emergency Planning

During the training and pre-work safety meetings, employees involved in this task shall be trained and reminded of the provisions of the plant emergency procedure, alarm signals and communications, evacuation routes, emergency reporting, and the importance of maintaining continual communications with FMPC Emergency Preparedness personnel via two-way radio or cellular phone.

12.3 Lines of Authority

The RUST Project Engineer or his designated representative, has the primary responsibility for the prevention of and the initial response to emergency conditions. The RUST Project Engineer will direct emergency response actions at the work site until relieved by the WMCO Assistant Emergency Duty Officer (AEDO), or the Emergency Response Team. In the event an emergency does occur, the individual involved in or observing the condition shall immediately notify the following personnel in order of availability: the RUST Project Engineer; the communications center; the AEDO; the WMCO Health and Safety Officer; the Project Engineer/Operable Unit Manager.

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The AEDO is responsible for ensuring that corrective actions have been implemented, the appropriate personnel notified, and reports completed as required. Personnel observing unsafe conditions at the work site shall report same to the RUST Project Engineer or to the WMCO Health and Safety Officer, who will stop work activity in the affected area until the hazardous condition can be remedied.

12.4 Evacuation

In the event an evacuation of the waste pit and Clearwell area is required, the RUST Project Engineer will be responsible for notifying all personnel involved. All personnel will proceed to the rally point as designated by the RUST Project Engineer. The FMPC-designated rally points within the DOE property are shown on Figure 12-1. The designated location for the waste pits area is Rally Point 6. This rally point is situated adjacent to the water tower and Plant 1. When the RUST Project Engineer is informed that an all-clear condition has been achieved, personnel will be released from the rally point.

In the event of an emergency which necessitates an evacuation of the Exclusion Area, the 2-2, 2-2 alarm signal shall be sounded over the plant alarm system; a voice message will follow over the Emergency Message System (EMS) instructing employees to go to their designated rally points. Personnel shall immediately proceed to the rally point. Personnel will follow instructions given by the rally point coordinator and participate in the accountability process. When an all-clear condition has been achieved, personnel will be released from the rally point. It is conceivable that the plant alarm signal or EMS will not be audible in certain remote locations of the work area. For this reason, communications with the FMPC communications control center via two-way radio or cellular phone will be maintained at all times by the RUST Project Engineer.

12.5 Emergency Equipment

The following safety equipment will be available for employee usage:

1) Fire extinguisher
2) Portable eyewash
3) Absorbent
4) Telephone
5) Spill drums
6) Two-way radio
7) Respirators
8) Clean-up materials
9) Local evacuation alarm
10) Life ring or ring buoy and attached rope.

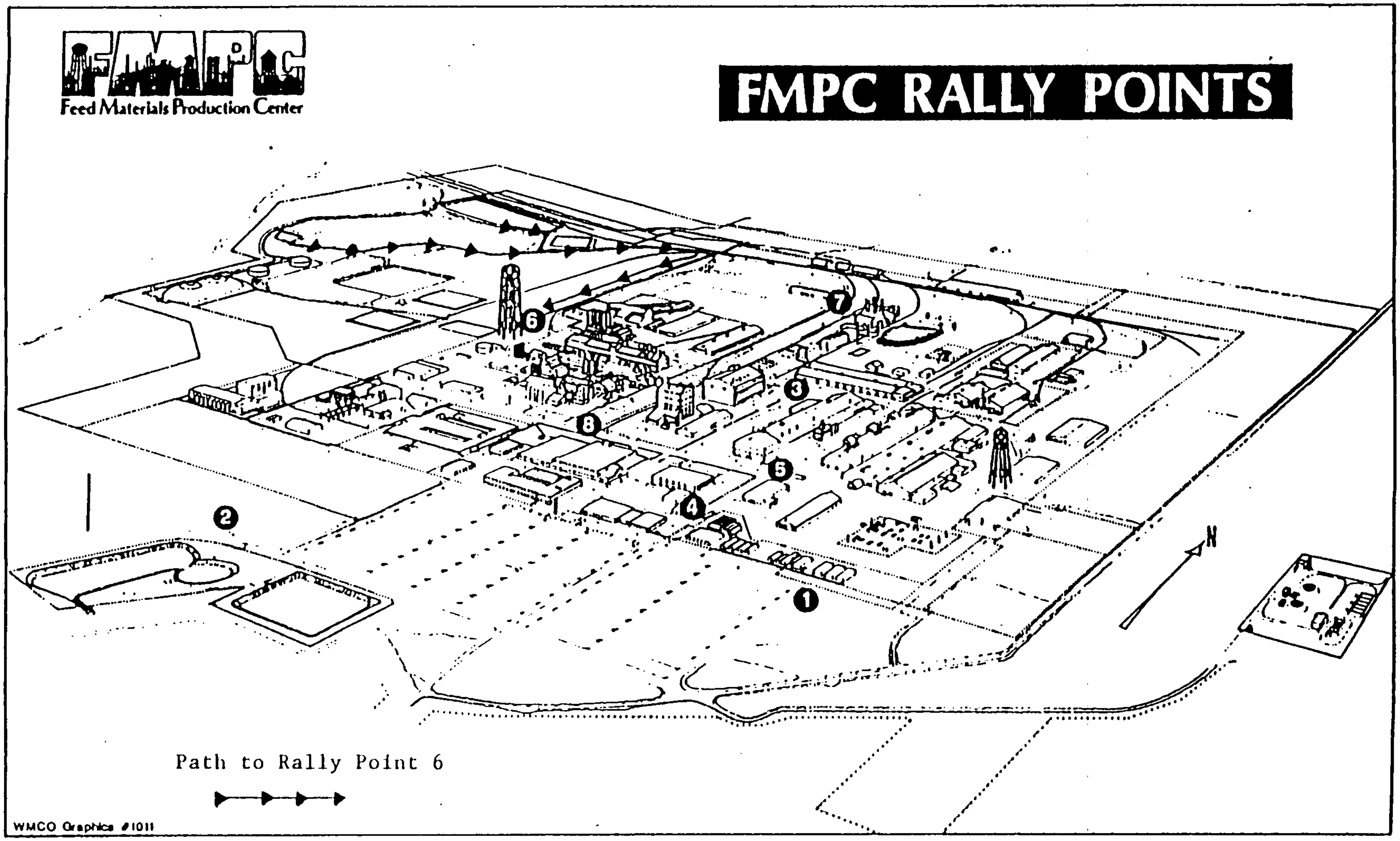

Figure 12-1 - FMPC Rally Points

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12.6 Emergency Notification

All emergencies, including spills, leaks, or dike failure shall be reported immediately. Emergencies can be reported by telephone dialing x6511 or by contacting the communications center via two-way radio. Any additional information pertaining to an emergency shall be reported to the responding personnel to assist in defining appropriate response to the emergency.

12.7 Fire, Explosion, or Medical Emergency

In the event of a fire, explosion, or medical emergency, the communication center shall be notified immediately by two-way radio, by manual fire alarm, or by calling x6511. The communication center operator will activate the emergency response team and dispatch them to the emergency location. If a fire is in the incipient stage and perceived controllable without endangering oneself, personnel may use available fire extinguishers. If it is not in the incipient stage, personnel in the immediate area shall evacuate to a safe position and await instructions.

If medical attention is required, and the nature of the injury or illness is minor the affected personnel shall be taken to the FMPC Medical Department Facility located as shown on Figure 12-2. The path from the waste pits and Clearwell area is also indicated on Figure 12.2. The FMPC ambulance will be called to transport individuals who have suffered major injury or illness.

12.8 Spill Control Contingency Plan

Spills, regardless of their size or the classification of the liquid, shall be reported immediately. Emergencies can be reported by telephone by dialing x6511 or by contacting the communications center via two-way radio. The Emergency Response Team and AEDO will respond to the spill according to the FMPC Spill Control Contingency Plan.

12.9 Additional Information

12.9.1 Hospitals

The FMPC Medical Department Facility (Building 53) is the primary choice for on-site injuries. The FMPC ambulance will transport the injured workers to the nearest hospital, if necessary. FMPC maintains an emergency response capability that includes an ambulance and Emergency Medical Technicians.

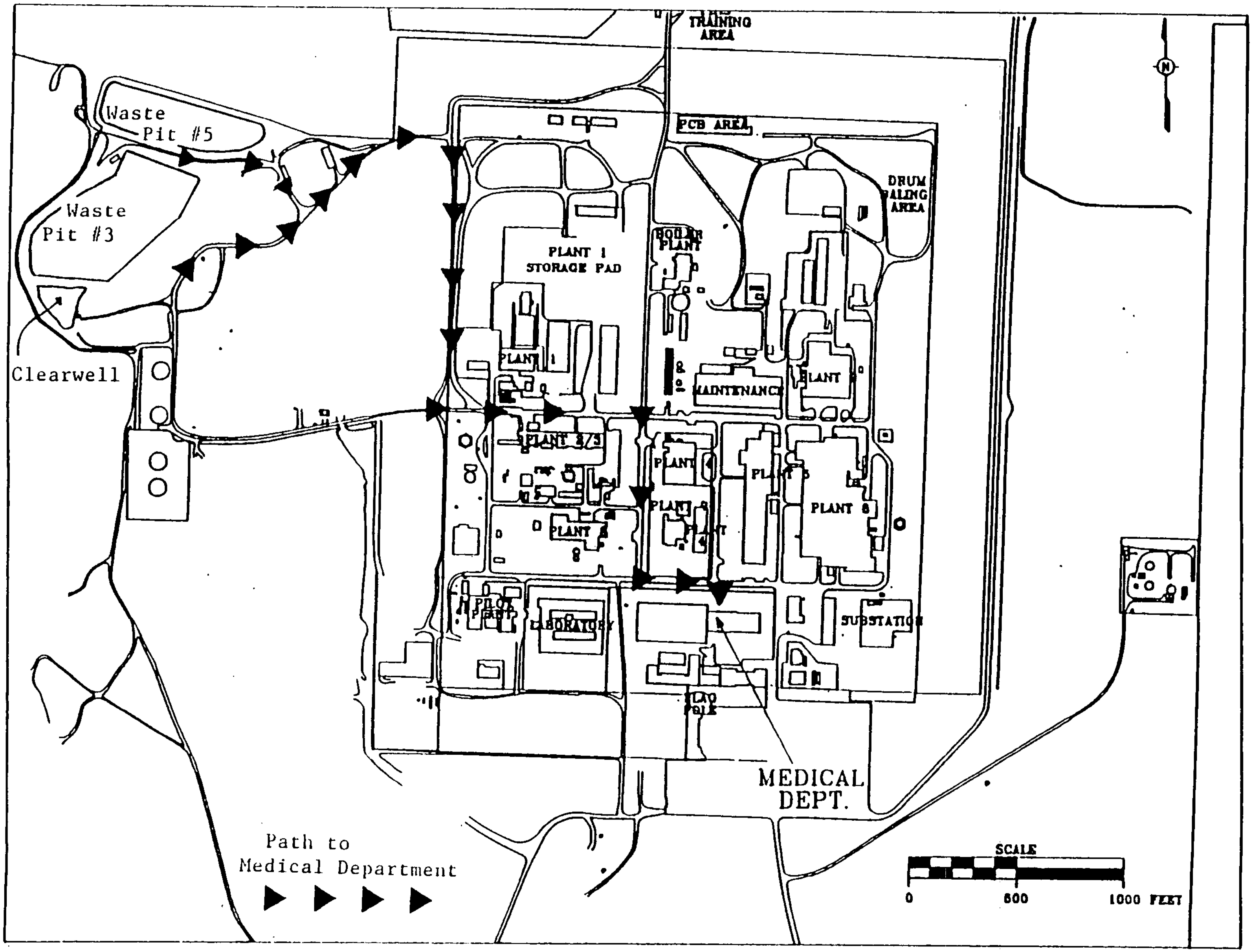

Figure 12-2 - Location of FMPC Medical Department Facility

12.9.2 Emergency Telephone Numbers

		Radio	Frequency
EMERGENCY RESPONSE	738-6511	Control	
Industrial Hygiene	738-6207	357	F2
Radiation Safety	738-6889	355	F2
Fire and Safety	738-6235	303	F2
(Safety and Health Officer)	738-6231		
Assistant Emergency Duty	738-6431	202	F2
Officer (AEDO)	or 738-6295		
RUST Project Engineer	738-6310		F6
(J.P. McCormack)			
RUST Safety and Health Officer	738-6820		F6
(Larry Welton)			
Ambulance	738-6511		
Hospital	738-6511		
Fire	738-6511		

SECTION 13

CONFINED SPACE ENTRY

A Confined Space Entry permit will not be required because there will not be any entries into confined spaces during the dike stability investigation.

SECTION 14

APPROVAL AND COMPLIANCE STATEMENT

14.1 Provisions

This site-specific Health and Safety Plan was produced for the FMPC and addresses safety-related aspects of all work related to the dike stability investigation on Waste Pits 3 and 5 and the Clearwell. Personnel who perform the tasks listed in Section 1 must read, understand, and agree to abide by the procedures set forth in both this Health and Safety Plan and any subsequent amendments. Site workers are required to sign the attached approval and compliance acknowledgement form.

14.2 Amendments to Plan

This Health and Safety Plan is based on information available at the time of preparation. Unexpected conditions may arise which require reassessment of safety procedures. Unplanned activities and/or changes in the hazard status shall require a review of, and may result in changes to, this plan. Changes in the anticipated hazard status or unplanned activities are to be recorded as an amendment to this plan. Amendments must be approved by the plan author and WMCO IRS&T must be notified in writing of plan amendments.

Compliance with the provisions of this Health and Safety Plan may be audited through announced or unannounced site visits. All provisions of this Health and Safety Plan are to be implemented. Reasons for field actions/changes, when they are necessary, should be fully documented.

HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT FORM

I have been informed and understand and will abide by the procedures set forth in the Health and Safety Plan and Amendments for the Dike Stability Investigation of Waste Pits 3 and 5 and the Clearwell at the FMPC site.

Printed Name	Signature	Representing	Date

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ATTACHMENT A

HEAT STRESS PROCEDURES

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Heat Stress and Other Physiological Factors

Wearing PPE puts a hazardous waste worker at considerable risk of developing heat stress. This can result in health effects ranging from transient heat fatigue to serious illness or death. Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, regular monitoring and other preventive precautions are vital.

Individuals vary in their susceptibility to heat stress. Factors that may predispose someone to heat stress include:

- Lack of physical fitness.
- Lack of acclimatization.
- Age.
- Dehydration.
- Obesity.
- Alcohol and drug use.
- Infection.
- Sunburn.
- Diarrhea.
- Chronic disease.

Reduced work tolerance and the increased risk of excessive heat stress is directly influenced by the amount and type of PPE worn. PPE adds weight and bulk, severely reduces the body's access to normal heat exchange mechanisms (evaporation, convection, and radiation), and increases energy expenditure. Therefore, when selecting PPE, each item's benefit should be carefully evaluated in relation to its potential for increasing tne risk of heat stress. Once PPE is selected, the safe duration of work/rest periods should be determined based on the:

- Anticipated work rate.
- Ambient temperature and other environmental factors.
- Type of protective ensemble.
- Individual worker characteristics and fitness.

Monitoring

Because the incidence of heat stress depends on a variety of factors, all workers, even those not wearing protective equipment, should be monitored.

- For workers wearing permeable clothing (e.g., standard cotton or synthetic work clothes), follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values for Heat Stress [11]. If the actual clothing worn differs from the ACGIH standard ensemble in insulation value and/or wind and vapor permeability, change the monitoring requirements and work/rest schedules accordingly [12].

Source:
NIOSH/OSHA/USCG/EPA Occupational Safety And Health Guidance Manual for Hazardous Waste Site Activities, October 1985.

- For workers wearing semipermeable or impermeable[1] encapsulating ensembles, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C) [6].

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

  If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third [12].

- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

  If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

  If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by *one-third* [12].

  Do *not* permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C)[12].

- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. *The body water loss should not exceed 1.5 percent total body weight loss in a work day* [12].

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see Table 8-10). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Prevention

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional heat injuries. To avoid heat stress, management should take the following steps:

- Adjust work schedules:

  Modify work/rest schedules according to monitoring requirements.

  Mandate work slowdowns as needed.

  Rotate personnel: alternate job functions to minimize overstress or overexertion at one task.

  Add additional personnel to work teams.

  Perform work during cooler hours of the day if possible or at night if adequate lighting can be provided.

- Provide shelter (air-conditioned, if possible) or shaded areas to protect personnel during rest periods.

- Maintain workers' body fluids at normal levels. This is necessary to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water lost in sweat, i.e., 8 fluid ounces (0.23 liters) of water must be ingested for approximately every 8 ounces (0.23 kg) of weight lost. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat [14]. When heavy sweating occurs, encourage the worker to drink more. The following strategies may be useful:

  Maintain water temperature at 50° to 60°F (10° to 15.6°C).

  Provide small disposable cups that hold about 4 ounces (0.1 liter).

  Have workers drink 16 ounces (0.5 liters) of fluid (preferably water or dilute drinks) before beginning work.

  Urge workers to drink a cup or two every 15 to 20 minutes, or at each monitoring break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.

  Weigh workers before and after work to determine if fluid replacement is adequate.

- Encourage workers to maintain an optimal level of physical fitness:

  Where indicated, acclimatize workers to site work conditions: temperature, protective clothing, and workload (see *Level of Acclimatization* at the end of this chapter).

  Urge workers to maintain normal weight levels.

- Provide cooling devices to aid natural body heat exchange during prolonged work or severe heat exposure. Cooling devices include:

  Field showers or hose-down areas to reduce body temperature and/or to cool off protective clothing.

  Cooling jackets, vests, or suits (see Table 8-5 for details).

- Train workers to recognize and treat heat stress. As part of training, identify the signs and symptoms of heat stress (see Table 8-11).

Other Factors

PPE decreases worker performance as compared to an unequipped individual. The magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. This section discusses the demonstrated physiological responses to PPE, the individual human characteristics that play a factor in these

[1]Although no protective ensemble is "completely" impermeable, for practical purposes an outfit may be considered impermeable when calculating heat stress risk.

Table 8-10. Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[a]

ADJUSTED TEMPERATURE[b]	NORMAL WORK ENSEMBLE[c]	IMPERMEABLE ENSEMBLE
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5°-90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

Source: Reference [13].

[a]For work levels of 250 kilocalories/hour.

[b]Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 × % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

[c]A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Table 8-11. Signs and Symptoms of Heat Stress[a]

- **Heat rash** may result from continuous exposure to heat or humid air.
- **Heat cramps** are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - muscle spasms
  - pain in the hands, feet, and abdomen
- **Heat exhaustion** occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:
  - pale, cool, moist skin
  - heavy sweating
  - dizziness
  - nausea
  - fainting
- **Heat stroke** is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - red, hot, usually dry skin
  - lack of or reduced perspiration
  - nausea
  - dizziness and confusion
  - strong, rapid pulse
  - coma

[a]Source: Reference [6].

responses, and some of the precautionary and training measures that need to be taken to avoid PPE-induced injury.

The physiological factors may affect worker ability to function using PPE include:

- Physical condition.
- Level of acclimatization.
- Age.
- Gender.
- Weight.

Physical Condition

Physical fitness is a major factor influencing a person's ability to perform work under heat stress. The more fit someone is, the more work they can safely perform. At a given level of work, a fit person, relative to an unfit person, will have [5,8,15,16]:

- Less physiological strain.
- A lower heart rate.
- A lower body temperature, which indicates less retained body heat (a rise in internal temperature precipitates heat injury).
- A more efficient sweating mechanism.
- Slightly lower oxygen consumption.
- Slightly lower carbon dioxide production.

Level of Acclimatization

The degree to which a worker's body has physiologically adjusted or acclimatized to working under hot conditions affects his or her ability to do work. Acclimatized individuals generally have lower heart rates and body temperatures than unacclimatized individuals [17], and sweat sooner and more profusely. This enables them to maintain lower skin and body temperatures at a given level of environmental heat and work loads than unacclimatized workers [18]. Sweat composition also becomes more dilute with acclimatization, which reduces salt loss [8].

Acclimatization can occur after just a few days of exposure to a hot environment [15,16]. NIOSH recommends a progressive 6-day acclimatization period for the unacclimatized worker before allowing him/her to do full work on a hot job [16]. Under this regimen, the first day of work on site is begun using only 50 percent of the anticipated workload and exposure time, and 10 percent is added each day through day 6 [16]. With fit or trained individuals, the acclimatization period may be shortened 2 or 3 days. However, workers can lose acclimitization in a matter of days, and work regimens should be adjusted to account for this.

When enclosed in an impermeable suit, fit acclimatized individuals sweat more profusely than unfit or unacclimatized individuals and may therefore actually face a greater danger of heat exhaustion due to rapid dehydration. This can be prevented by consuming adequate quantities of water. See previous section on *Prevention* for additional information.

Age

Generally, maximum work capacity declines with increasing age, but this is not always the case. Active, well-conditioned seniors often have performance capabilities equal to or greater than young sedentary individuals. However, there is some evidence, indicated by lower sweat rates and higher body core temperatures, that older individuals are less effective in compensating for a given level of environmental heat and work loads [19]. At moderate thermal loads, however, the physiological responses of "young" and "old" are similar and performance is not affected [19].

Age should not be the sole criterion for judging whether or not an individual should be subjected to moderate heat stress. Fitness level is a more important factor.

Gender

The literature indicates that females tolerate heat stress at least as well as their male counterparts [20]. Generally, a female's work capacity averages 10 to 30 percent less than that of a male [8]. The primary reasons for this are the greater oxygen-carrying capacity and the stronger heart in the male [15]. However, a similar situation exists as with aging: not all males have greater work capacities than all females.

Weight

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). Heat loss (dissipation) is a function of surface area and heat production is dependent on mass. Therefore, heat balance is described by the ratio of the two.

Since overweight individuals (those with a low ratio) produce more heat per unit of surface area than thin individuals (those with a high ratio), overweight individuals should be given special consideration in heat stress situations. However, when wearing impermeable clothing, the weight of an individual is not a critical factor in determining the ability to dissipate excess heat.

ATTACHMENT D

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U.S. DEPARTMENT OF ENERGY

FEED MATERIALS PRODUCTION CENTER

DOE Contract No. DE-AC05-90OR21951

PROJECT ORDER NUMBER 11

WBS No. 1.2.1.1.2.1.2

DIVISION 1 - GENERAL REQUIREMENTS

SPECIFICATIONS

Prepared by:

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U.S. DEPARTMENT OF ENERGY

FEED MATERIALS PRODUCTION CENTER

DOE Contract No. DE-AC05-900R21951

Project Order Number 11

Division 1 - General Requirements

Section 01410

PARSONS

Prepared by: Ken M. Erw 5/10/91
Geotechnical Engineer Date

Checked by: Scott J. Malletto for Scott Versluis 5/10/91
Lead Geotechnical Engineer Date

Approved by: Scott J. Malletto 5/10/91
OU-1 Manager Date

WESTINGHOUSE MATERIALS CO. OF OHIO

Approved by: ______________________
Project Engineer Date

Approved by: ______________________
OU-1 Manager Date

U.S. DEPARTMENT OF ENERGY

Approved by: ______________________
OU-1 Manager Date

Approved by: ______________________
Project Manager Date

Date: 05/10/91
Rev. No.: 1

WBS No.: 1.2.1.1.2.1.2
ERA/OU No.: 1

SECTION 01410
TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Soil laboratory testing requirements for soil samples obtained from a subsurface soils investigation of Waste Pits 3 and 5, and the Clearwell dikes at the Feed Materials Production Center (FMPC), Fernald, Ohio.

1. The work under these specifications consists of furnishing supervision, labor, materials, equipment, and facilities to perform soils testing in accordance with this specification.

2. Estimated sample quantities and testing requirements are summarized in Table 1.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1.	ASTM D422 E1-63	Standard Test Method for Particle-Size Analysis of Soils (R 1990)
2.	ASTM D653-90	Standard Terminology Relating to Soil, Rock, and Contained Fluids
3.	ASTM D854-83	Standard Test Method for Specific Gravity of Soils
4.	ASTM D1586-84	Standard Method for Penetration Test and Split-Barrel Sampling of Soils

5. ASTM D1587-83 — Standard Practice for Thin-Walled Tube Sampling of Soils

6. ASTM D2216-80 — Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures

7. ASTM D2217-85 — Standard Practice for Wet Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

8. ASTM D2434-68 — Standard Test Method for Permeability of Granular Soils (Constant Head)

9. ASTM D2435-80 — Standard Test Method for One-Dimensional Consolidation Properties of Soils

10. ASTM D2850-87 — Standard Test Method for Unconsolidated, Undrained, Compressive Strength of Cohesive Soils in Triaxial Compression

11. ASTM D4220-89 — Standard Practice for Preserving and Transporting Soil Samples

12. ASTM D4318-84 — Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

13. ASTM D4643-87 — Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method

14. ASTM D4767-88 — Standard Test Method for Consolidated Undrained Triaxial Compression Test on Cohesive Soils

B. U.S. Army Corps of Engineers (COE), Engineering and Design Laboratory Soils Testing Manual (EM-1110-2-1906)

1. COE, Appendix II — Unit Weights, Void Ratio, Porosity, and Degree of Saturation

2. COE, Appendix VII — Permeability Tests

C. Supplemental Information

1. Soil Investigation Plan for Dike Stability Analysis of Waste Pits 3 and 5, and the Clearwell, Parsons, May 1991.

2. Feed Materials Production Center (FMPC) Remedial Investigation/ Feasibility (RI/FS) Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988.

3. Westinghouse Materials Company of Ohio (WMCO): WMCO FMPC-711, Site Policy and Procedure, "Quality Levels", Revision 1, December 1989.

1.03 PROJECT CONDITIONS

A. Some soil samples may be contaminated with radioactive or hazardous substances and thus will require special precautions in the laboratory. Documentation accompanying soil samples will provide field radiological and environmental safety monitoring results. The laboratory shall be equipped to perform soil testing on contaminated samples.

1.04 DEFINITIONS

A. Terms and symbols used shall conform to ASTM D653.

1.05 SUBMITTALS

A. Pre-testing Documents

1. The Subcontractor shall submit the following engineering documents to WMCO/Parsons for review and comment prior to beginning testing.
   a. Format of testing forms and final reports
   b. Description of applicable laboratory equipment
   c. Testing procedures including selected options within the standard procedures
   d. Description of any deviation and justification for deviation from standard procedures.

2. The Subcontractor shall submit the following quality verification documents within 15 days after contract award:
   a. Quality Assurance Manual including procedures.
   b. List and format of required records and reports.

B. Test Results and Reports

1. The Subcontractor shall submit two final copies of test results to WMCO/Parsons within 45 calendar days after receiving the sample(s).
2. The Subcontractor shall submit preliminary copies of test results to WMCO/Parsons weekly as they become available.
3. The Subcontractor shall submit within 15 calendar days after the completion of the laboratory testing, two copies of a reproducible typed final report. The report shall include the following:

a. Detailed test results in tabulated and/or graphical form
b. Back up calculations, graphs, etc. required by the test procedures
c. A narrative description of the methods and procedures used for analysis
d. Description of equipment used and calibration procedures
e. A listing of sample preparation and handling procedures
f. Description of soil sample quality
g. A signature attesting to the accuracy of the data
h. A summary of inspection records per Appendix A
i. A summary of calibration records per Appendix A.

1.06 QUALITY ASSURANCE

A. The subcontractor shall meet the quality assurance requirments of Appendix A. The requirements are based on WMCO FMPC-711. Appendix A was developed using guidance provided in Sections 7.0 through 18.0 of RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)", Revision 3, March 1988.

1.07 PACKAGING, SHIPPING, STORAGE, AND HANDLING OF SOIL SAMPLES

A. Samples shipped to the laboratory shall be obtained by others utilizing ASTM D1586 (split-barrel sampling) or ASTM D1587 (thin-walled tube sampling) methods.

B. Samples shipped to the laboratory by others shall be packaged, handled, and shipped from the site in accordance with applicable transportation regulations and in a manner to ensure minimum disturbance (ASTM 4220). After arrival at the laboratory, the samples shall be stored in the soil laboratory until commencement of testing. Samples shall be protected against exposure, excessive temperature changes, loss of moisture, and disturbance while in the laboratory. After completion of soil testing, unused portions of undisturbed samples shall be sealed to prevent loss of moisture. The samples shall be labeled and kept in storage until disposal, as advised by WMCO/Parsons.

C. Split-barrel samples (ASTM D1586) shall meet the packaging, shipping, storage, and handling practices of ASTM D4220 Group B soil samples.

D. Shelby tube samples (ASTM D1587) shall meet the packaging, shipping, storage, and handling practices of ASTM D4220 Group C soil samples.

E. Soil samples shall be shipped to the laboratory in batches by others. The Chain of Custody procedures described in Section 7.0 of the FMPC Remedial Investigation/ Feasibility (RI/FS) Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)," Revision 3, March 1988 will be used. "Chain of Custody Record" and "Laboratory Request for Analysis" forms shall accompany each batch of samples. The WMCO/Parsons Engineer shall list the required tests for each sample on the associated Laboratory Request for Analysis form. The WMCO/Parsons Engineer may require additional testing on selected samples via separate communication with the laboratory.

F. After arrival of the soil samples from the field, the laboratory shall check for the following information on the labels attached to the samples:
   1. Project number and site
   2. Boring Number
   3. Sample Number
   4. Date of Sample
   5. Depth of Sample.

   If any of this information is missing, it shall be corrected before testing is started.

G. Prior to conducting tests, samples shall be examined to verify classification made in the field.

PART 2 PRODUCTS

Not applicable.

PART 3 EXECUTION

3.01 SOIL INDEX AND CLASSIFICATION PROPERTIES TESTING

A. Designated Split-barrel and Shelby tube soil samples from the work site shall be tested for index and classification properties. These tests shall consist of natural water content, particle size analysis, Atterberg limits, specific gravity and unit weight. The WMCO/Parsons Engineer may require additional tests based on field findings.

B. Samples shall be prepared for particle-size analysis and determination of soil constants in accordance with Procedure B of ASTM D2217.

C. The following standards/procedures shall be used:

Test	Standard/Procedure	Notes
Natural Water Content	ASTM D2216	1. ASTM D4643 is also acceptable.
Particle-size Analysis	ASTM D422	1. Stirring apparatus B (air dispersion) shall be used. 2. Soil is anticipated to be mostly clay and silt sizes.
Atterberg Limits	ASTM D4318	1. Procedure A (multipoint using a wet preparation) shall be used.
Specific Gravity	ASTM D854	

Unit Weight	COE, Appendix II	1. Dry and wet unit weights shall be determined.

3.02 SOIL PHYSICAL PROPERTIES TESTING

A. Designated Shelby tube soil samples shall be tested for physical properties. The tests shall consist of One-dimensional Consolidation Properties of Soils, Unconsolidated-Undrained (UU) Compressive Strength of Cohesive Soils in Triaxial Compression , Consolidated-Undrained (CU) Compressive Strength of Cohesive Soils in Triaxial Compression, and permeability tests. The WMCO/Parsons Engineer may require additional tests based on field findings.

B. The following standards/procedures shall be used:

Test	Standard/Procedure	Notes
One-dimensional Consolidation Properties of Soils	ASTM D2435	1. Perform test initially at the soil's natural water content. 2. Tests shall be carried to 15 ksf loading. 3. For unsaturated natural soil, load to 15 ksf, unload to estimated value of in situ overburden pressure, saturate soil and reload to 15 ksf. 4. For samples obtained below water table, perform test with the soil sample saturated.

Unconsolidated-Undrained (UU) Compressive Strength of Cohesive Soils in Triaxial Compression	ASTM D2850	1. Perform tests at confining pressures of 1.0, 2.0, and 4.0 ksf.
Consolidated-Undrained (CU) Compressive Strength of Cohesive Soils in Triaxial Compression	ASTM D4767	1. B-value shall be at least 0.95 prior to deviator stress application. 2. Pore water pressure shall be measured to obtain effective stress parameters. 3. Test confining pressures: for sample depths less than or equal to 30 feet, use 1.0, 3.0, and 5.0 ksf. For sample depths greater than 30 feet, use 2.0, 5.0, and 8.0 ksf.
Constant Head Permeability Test	ASTM D2434	
Falling Head Permeability Test	COE Appendix VII	

3.03 SCHEDULES

A. Attachments

1. Table 1 — Estimated Sampling and Testing Requirements for Dike Stability Analysis of Waste Pits 3 and 5, and the Clearwell.

2. Appendix A — Quality Assurance Requirements

END OF SECTION

TABLE 1

ESTIMATED SAMPLING AND TESTING REQUIREMENTS FOR WASTE PITS 3 AND 5, AND CLEARWELL DIKE STABILITY ANALYSIS

BORING NO.	BORING DEPTH (FT)	18 IN. SPLIT BARREL SAMPLES (#)	24 IN. SHELBY TUBE SAMPLES (#)	SPECIFIC GRAVITY (#)	UNIT WEIGHT (#)	MOISTURE CONTENT (#)	INDEX TESTS: PARTICLE ANALYSIS (#)	INDEX TESTS: ATTERBERG LIMITS (#)	PHYSICAL PROPERTIES TESTS: TRIAXIAL COMPRESSION UU (#)	PHYSICAL PROPERTIES TESTS: TRIAXIAL COMPRESSION CU (#)	PHYSICAL PROPERTIES TESTS: FALLING HEAD PERM (#)	PHYSICAL PROPERTIES TESTS: CONSTANT HEAD PERM (#)	PHYSICAL PROPERTIES TESTS: 1-D CONSOLID. (#)
B5-1	15	8	1			5	2	3	1	1	1		1
B5-3	35	20	2	1	1	12	4	6		3	1	1	1
B5-4	15	8	1			5	2	3	1	1	1		
B5-6	35	20	2	1	1	12	4	6		3	1		
B5-7	15	8	1			5	2	3	1	1	1		1
B5-9	35	20	2	1	1	12	4	6		3	1	1	1
B5-10	15	8	1			5	2	3	1	1	1		
B5-12	35	20	2	1	1	12	4	6		3	1		
B5-13	20	12	1			7	2	3	1	1	1		1
B5-15	35	20	2	1	1	12	4	6		3	1	1	1
B3-1	10	5	1			3	2	3	1	1	1		1
B3-3	25	14	2	1	1	9	4	6		3	1	1	1
B3-4	5	2	1			2	2	3	1	1	1		1
B3-6	25	14	2	1	1	9	4	6		3	1	1	1
BC-1	5	2	1			2	2	3	1	1	1		1
BC-3	15	7	2	1	1	6	4	6		3	1	1	1
TOTALS	340	188	24	8	8	118	48	72	8	32	16	6	12

NOTES: 1. The above listed quantities are estimates only. Actual quantities will be based on actual samples obtained in the field.

2. Boring depth based on bottom of boring elevation = 555 feet (MSL)

APPENDIX A

Quality Assurance Quality Level 3

The Subcontractor shall be responsible for the development, implementation, and maintenance of a quality assurance program consistent with the requirements of this appendix. This appendix was developed using guidance provided in Sections 7.0 through 18.0 of the RI/FS Work Plan, Volume V, "Quality Assurance Project Plan (QAPP)" Revision 3, March 1988.

1. Personnel Qualifications

Laboratory supervisory personnel and test technicians shall have five or more years experience or training in soil and rock testing. Personnel supervising, evaluating, and performing tests shall be qualified in accordance with the requirements described in the Subcontractor's Quality Assurance Program. Only personnel qualified in accordance with the Quality Assurance Program shall perform, supervise, review, and approve reports of testing required by this specification.

2. Instructions, Procedures, and Drawings

Activities affecting quality--such as test methods used, the performance of tests, development of reports, maintenance of records, and the processing and validity of data and documentation--shall be prescribed by and accomplished in accordance with documented instructions and procedures. These documents shall include appropriate acceptance criteria for determining that the activities have been accomplished satisfactorily.

3. Document Control

The preparation, review, approval, issue, and revision of documents that specify quality requirements or prescribe quality activities shall be controlled in accordance with documented procedures. Controlled documents and revisions shall be reviewed and approved by authorized personnel. The Subcontractor shall maintain documentation for quality related activities and material in a format acceptable to WMCO/Parsons.

4. Inspection/Surveillance

The Subcontractor shall establish and implement a program of inspections and surveillance to ensure that items conform to specified requirements. The program shall include monitoring of measuring and test equipment (including calibration of all sieves used in testing), identification and control of samples, storage of samples and use of proper test methods in accordance with referenced standards and the Subcontractor's procedures. Inspection and surveillance results shall be documented and shall be performed by qualified personnel other than those performing the activity. Inspectors shall not report to supervisors responsible for the work being inspected or surveilled. Hold points shall be specified in appropriate documents and approved by WMCO/Parsons. The consent to waive hold points shall be documented. If sampling inspection is employed, the sampling procedures shall be based on recognized standard practice. When direct inspection or surveillance of in-process activities is not possible, indirect process monitoring methods shall be provided. Records shall identify the item or process, the date, inspector, type of observation, results, acceptability, and reference to information on action taken in connection with nonconformances.

5. Control of Measuring and Test Equipment

The Subcontractor shall establish and implement procedures to ensure measuring and test equipment used in activities affecting quality are properly controlled, calibrated,and adjusted at specified periods to maintain accuracy within necessary limits. Measuring and test equipment shall be calibrated to standards traceable to the National Institute of Standards and Technology or nationally recognized standards. The method and calibration interval for each item shall be defined in calibration procedures. When measuring and test equipment is found to be out of calibration, an evaluation shall be made and documented of the validity of previous data. Measuring and test equipment consistently found to be out of calibration shall be repaired or

Record transmittal, distribution, retention, maintenance, review for completeness, and disposition requirements and responsibilities shall be established and documented.

replaced. Calibration records shall be maintained and equipment suitably marked to indicate calibration status.

The Subcontractor shall keep a current list of testing equipment and the dates each unit was calibrated. He shall also affix a sticker to the equipment to identify the date of certification and the date that recalibration is required. No equipment which requires calibration shall be used unless it is calibrated.

6. Handling, Storage, and Preservation

The Subcontractor shall control the selection, identification, conditioning, handling, storage, and preservation of samples to prevent damage or loss and to minimize deterioration. When necessary, special equipment and special protective environments shall be specified, provided, and their existence verified. Special handling tools and equipment shall be inspected and tested in accordance with written procedures and at specified times to verify that the tools and equipment are adequately maintained. The identification of the item shall be adequate to identify, maintain, and preserve the sample, including the indication of the need for special environments or special controls.

7. Control of Nonconforming Items

Nonconforming conditions, such as malfunctions, failures, deficiencies, and procedural deviations shall be identified and dispositioned in accordance with written procedures. The responsibility and authority for the disposition of nonconforming conditions shall be defined in the procedure.

8. Quality Assurance Records

The Subcontractor shall develop records management procedures to control the preparation, review, and maintenance of records sufficient to furnish documentary evidence of quality. Records shall be legible, identifiable, retrievable, and protected against damage, deterioration, or loss.